UNIVERSITI TEKNOLOGI MARA

DETERMINING SCHOLARSHIP RECIPIENTS AMONG STUDENTS OF UITM PERLIS BY USING FUZZY MULTI-ATTRIBUTE DECISION MAKING (FMADM) WITH TOPSIS METHOD

NORHAFIZZAH BINTI ZURAIMI

BACHELOR OF SCIENCE (Hons.)
BACHELOR OF SCIENCES (Hons.) MANAGEMENT MATHEMATIC

JANUARY 2021

Universiti Teknologi MARA

Determining Scholarship Recipients Among Students of UiTM Perlis by Using Fuzzy Multi-Attribute Decision Making (FMADM) with TOPSIS Method

Norhafizzah Binti Zuraimi

Report submitted in fulfilment of the requirements for

Bachelor of Science (Hons.) Management Mathematics

Faculty of Computer and Mathematical Sciences

January 2021

SUPERVISOR'S APPROVAL

DETERMINING SCHOLARSHIP RECIPIENTS AMONG STUDENTS OF UITM PERLIS BY USING FUZZY MULTI-ATTRIBUTE DECISION MAKING (FMADM) WITH TOPSIS METHOD

By

NORHAFIZZAH BINTI ZURAIMI
2019728259

This report was prepared under the direction of supervisor, Puan Suzanawati Binti Abu Hasan. It was submitted to the Faculty of Computer and Mathematical Sciences and was accepted in partial fulfilment of the requirements for the degree of Bachelor of Science (Hons.) Management Mathematics.

Approved by:

....
Suzanawati Binti Abu Hasan
Supervisor

JANUARY 27, 2021

STUDENT'S DECLARATION

I certify that this report and the research to which it refers are the product of my own work and that any ideas or quotation from the work of other people, published or otherwise are fully acknowledged in accordance with the standard referring practices of the discipline.

…..........*hafizzah*..............

NORHAFIZZAH BINTI ZURAIMI

2019728259

JANUARY 27, 2021

ACKNOWLEDGEMENTS

In the name of Allah S.W.T, the Most Gracious and the Most Merciful. Alhamdulillah, all praises and thanks to Allah and His blessings for the completion of this study. First of all, my special thanks go to my supervisor, Puan Suzanawati Binti Abu Hasan for her guidance on this study, the endless support and time have given due to this study. Any idea and knowledge received from her had been submitted through this study.

Next, I would like to thank my lecturer of this subject, Puan Diana Sirmayunie Binti Mohd Nasir for her guidance on this study in helping me and my classmates during the lecture class by giving lectures about this final year project and give explanations about what things must be included in this study. It is a pleasure and an honor to be a lecturer in the Final Year Project (MSP660).

Last but not least, my deepest gratitude goes to all my family members. It would not be possible to finish this study without support from them. I am very thankful to my family for their prayers, understanding, and help throughout doing and finishing this study.

I want to give my special thanks to my friend, classmates, and students UiTM Perlis who took part in answering my questionnaire and help me during doing this study. May Allah S.W.T shower them with success and honor in their life.

ABSTRACT

Scholarships are given to fund a student's education and are provided by the government, non-governmental organisations (NGOs), the private sector, government-linked companies (GLCs), and trade associations. Many students apply for scholarships to continue their studies. So, it will be a long process to select the rightful candidates, which involves a significant length of time because the interview will be consisting of hundreds of applicants. This study aims to rank and determine the best alternative among scholarship recipients. In this study, the Fuzzy Multi-Attribute Decision Making (FMADM) with the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is used to solve this problem. The model was run using Microsoft Excel. The selection of scholarship recipients is based on a set of criteria that had been set; which are family income (C1), Grade Point Average (C2), the number of dependents in the family (C3), and the number of involvements in associations or activities in university (C4). The findings show that from 30 samples of students of Universiti Teknologi MARA (UiTM) Perlis, the 29^{th} student (S29) is in the highest-ranking with a 0.6948 closeness coefficient while the 16^{th} student (S16) is in the lowest ranking with a 0.1960 closeness coefficient. It is also shown that ten students meet the qualification that had been set by using closeness coefficients which are 0.5 and above to receive the scholarship. Therefore, using this method, the mistakes in the selection process will be reduced compared to manual selection. Besides, multi-attribute decision making can be solved using other methods instead of the TOPSIS method.

Keywords: Scholarship, Fuzzy Multi-Attribute Decision Making, FMADM, Technique for Order of Preference by Similarity to Ideal Solution, TOPSIS, rank, alternative.

TABLE OF CONTENTS

CONTENTS **PAGE**

CHAPTER THREE: RESEARCH METHODOLOGY

CHAPTER FOUR: RESULTS AND DISCUSSION

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

This chapter presents the information to determine scholarship recipients among students. It also explains the problems that exist and gives justification for why the research is conducted.

1.1 Background of the Study

A scholarship is an award of financial aid for a student to further their study at a higher level. Typically, scholarships are given to fund a student's education and are granted by the government, non-governmental organisations, the private sector, government-linked companies (GLC) and trade associations. The selected students under the scholarship program must fulfil some criteria or achievement set by the organisation.

Scholarship can help students from lower-income families to continue their studies. According to Omeje and Abugu (2015), scholarships should be offered to the poor, who eat at least twice a day, find it hard to pay tuition fees and often find it hard to clothe themselves. Without scholarships, students may have trouble continuing their studies in higher education. Nowadays, the global economy is getting worst day by day; it may affect people's financial, especially those students who need good expenses to accommodate their life and duty as students. Hence, they should apply for scholarships to ease their financial burden.

Scholarships will encourage the selected students to be successful in their studies. Mesran et al. (2017) stated that distributed scholarships could improve the learner's learning ability. In order to obtain the scholarship, thorough and specific rules and procedures have been established. A board of interviewers consisting of top management or leaders of the organisation will select the scholarship's recipients, therefore making the selection better.

Scholarships are awarded to students worldwide, and there are two types of scholarships: the local scholarship and international scholarship. According to Wimatsari, Putra, and Buana (2013), one of the universities that give their students scholarships is the University of Udayana, Bali, Indonesia. To select the rightful candidates is a long process that involves a significant length of time because the interview will comprise hundreds of applicants. A thorough interview for each of the candidates must also be done, as there are several criteria set by the organisation which had to be obliged.

In Malaysia, several parties such as universities, Bank Negara Malaysia, Yayasan Khazanah, Yayasan Sime Darby, and Jabatan Perkhidmatan Awam (JPA) are offering scholarships for students based on their course at the university. Scholarships’ applicants also need to complete the documents required by the parties who were offering the scholarship to apply for the scholarship. Irvanizam (2017) claims that one of Indonesia’s public universities, Syiah Kuala University, has offered students different types of scholarships in a variety of programs. They need to submit all the required documents such as their student registration, their tuition fees’ payments, and their academic transcript through the faculties that will be checked, selected and ranked by the committee to choose the scholarship recipients.

1.2 Problem Statement

Most students apply for education loans such as from Perbadanan Tabung Pendidikan Tinggi Nasional (PTPTN) and Majlis Amanah Rakyat (MARA) instead of scholarship. The reason is that most scholarships require specific criteria to be fulfilled; unfortunately, they do not meet the required criteria. According to Maseleno et al. (2018), the problem that is faced by the candidates who wish to get the scholarships is that not all potential applicants are guaranteed to be accepted although they met all the requirements.

In Malaysia, most of the method of selecting students for scholarships is through the manual, for example, Universiti Utara Malaysia (Shamshuritawati et al, 2015). The manual way is inefficient, and it has too many disadvantages which can lead to a biased result. It also takes a lot of time in the selection process as many students apply for the scholarship.

Therefore, in order to find the best solution in selecting the scholarship recipients, this study will be using Fuzzy Multi-Attribute Decision Making (FMADM) with the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method. By using this method, the interviewer or selector will choose the rightful scholarship recipients in a faster and convenient way compared to manual approach. This solution is also easy to utilise, and the decision made will be fair. Anamisa et al. (2018) argued that there might be a time where a scholarship is not delivered to the right individuals. When the interviewers use this proposed system, the results will be fair based on the criteria set. The process of determining the recipient for the said scholarship will be accurate, with a decision support system.

1.3 Objective of the Study

This study's main objective is to determine scholarship recipients among university students. The sub-objectives are:

i. To formulate a model in assisting the decision making to handle the vagueness of the criteria.
ii. To execute the decision support system in ranking the best alternative among the scholarship recipient using Fuzzy MADM and TOPSIS methods.

1.4 Scope of the Study

The research's scope is regarding the selection of scholarship recipients among 30 students of Universiti Teknologi MARA (UiTM) Perlis. The selection is based on criteria that had been set, which are family income (C1), Grade Point Average (C2), the number of dependents in the family (C3), and the number of involvements in associations or activities in university (C4).

1.5 Significance of the Study

This study is beneficial to at least three parties: students, the selector/interviewer, and future researchers. Firstly, the scholarship grantees who fulfil the criteria will gain a huge of benefits from this system. These students have a high potential to get scholarships since they have met the required criteria. Apart from the potential recipients, this study will serve the selectors very well. Since this selection uses the system, the selector will be released from the burden of selecting the scholarship recipients manually. Finally, future researchers will be grateful to have encountered this research as this study will be one of their references to come up with more interesting research and systems; and may encourage them to explore further in this field.

CHAPTER 2

LITERATURE REVIEW

2.1 History of Fuzzy Multi-Attribute Decision Making with TOPSIS Model

Fuzzy Multi-Attribute Decision Making (FMADM) is a method or approach by giving a weighted score for the criteria. According to Irvanizam (2018), a decision-making method was developed by several researchers utilising MADM method to solve decision-making problems. The MADM method concentrated on how people who make decision or experts provide the weighting value of criteria based on references in their application systems. They provided numeric values to make the calculation easier. There are three approaches to determining the attributes' weight score, which are subjective, objective, and integration between subjective and objective approaches. There are several ways to solve FMADM problems, such as the ELECTRE model, Simple Additive Weighting (SAW) model, Analytic Hierarchy Process (AHP) model, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) model, and Weighted Product (WP) model.

In 1981, Yoon and Hwang first introduced the TOPSIS model for solving the FMADM problem. By comparing each of the alternatives, this method gives the best solution. This method is also used to make a comparison by applying the distance. The TOPSIS model approach chooses the closest distance from the positive ideal solution as the best and optimal alternative. In contrast, the farthest distance from the negative ideal solution is the worst alternative in geometric viewpoint using Euclidean distance. Thus, by comparing each alternative, the researcher can observe the best or the worst alternatives among the alternatives problem (Saragih, Marbun & Reza, 2013).

According to Madi, Garibaldi & Wagner (2015), there are two types of Fuzzy TOPSIS system: Chen's Fuzzy TOPSIS and Yuen's Fuzzy TOPSIS. In 2000, Chen replaced the numeric linguistic scales for rating and weighting by applying fuzzy triangular numbers to the traditional Fuzzy TOPSIS system in order to expand the TOPSIS system into a fuzzy environment. In 2014, Yuen suggested a new Fuzzy TOPSIS system that follows the implementation of a two-dimensional scale to address the dynamic phenomena in the rating process of decision-makers. From the comparison, the differences between the traditional fuzzy TOPSIS and the new fuzzy TOPSIS systems were illustrated from the formulated example where they happen in the definition steps of the scale, rating, and an ideal solution. The final ranking of alternatives shows the same result for both methods. Thus, Yuen’s method will focus on exploring the effect of varying individual hedges and showing how the additional information captured in these hedges provides different outputs compared to Chen’s approach. As clearly, Yuen's method is more significant in terms of expert time, work-intensive, and more computational that was important to establish what value the additional effort can provide and in which situations it was warranted.

2.2 Application of Fuzzy Multi-Attribute Decision Making with TOPSIS Model

Fuzzy MADM with TOPSIS problems has attracted many researchers with various case studies to explore the methods of decision making. One of the previous studies used Fuzzy TOPSIS to evaluate machining system using sustainability metrics. According to Digalwar (2018), sustainable manufacturing methods in metal cutting were identified and evaluated by the researcher using some alternatives such as dry machining, cryogenic machining, MQL machining, and HPJAM. The researcher used the Fuzzy TOPSIS method to find the most suitable machining techniques among the alternatives. By using this method, the complicated arithmetic operations on fuzzy triangular numbers can be avoided to save time. In the said study, the research output implies that the better alternative and sustainable manufacturing techniques is cryogenic machining.

Fathi et al. (2011) develop a model using the Fuzzy TOPSIS method to hire Padir Company personnel in Iran. The researcher did this study to fulfil the demand of world markets to have a quality and professional personnel due to the increasing competition of globalisation and fast technological improvements. This method was applied to determine the most appropriate and eligible person to be hired by this company. By applying for fuzzy triangular numbers in this study, the hiring manager is able to adjust the rating and fuzzy weight of the attributes. Four individuals were used as an alternative assessment, and the fuzzy operators were used to select the best alternatives. The collective score for these four alternatives is ultimately ranked, and the best alternative or option that the organisation should be hiring is the second person.

Another study by Azizi, Aikhuele and Souleman (2015) used the Fuzzy TOPSIS model to give rank for automotive suppliers. This study applied the fuzzy triangular set to handle the issue. According to the TOPSIS model, the proposed model is to determine the best ranking of alternatives between suppliers. There are six criterias and 18 sub-criterias used to select the best suppliers among the four suppliers. These suppliers were labelled Factory A, Factory B, Factory C and Factory D. The selection process was carried out using the Fuzzy TOPSIS method. Finally, Factory A was chosen as the best supplier in the automotive industry because supplier A's distance is the closest to the coefficient, which is 0.5407. At the same time, Factory D is the worst supplier in the automotive industry with a 0.5347 closeness coefficient.

Another research has been done by Ariapour, Veisanloo, and Asgari (2014) regarding the selection of plants in Rangeland, Iran. This research proposed using Fuzzy TOPSIS method in order to decide the suitable species of plant to cultivate in this plantation area. The right species selection is important for successful plantation management planning. This research investigated three types of species which are Bromus tomentellus (A1), Astragalus gossypinus (A2), and Hordeum bulbosum (A3) as the alternative with four criteria to find the best species that can be planted in this area. The result shows that Bromus tomentellus is ranked at the first place among the other species as it is the best species that can be planted in this area. It has the highest closeness coefficient, which is 0.640. The last place for this selection is Hordeum bulbosum with a 0.335 closeness coefficient which is unsuitable to be planted in the area.

One of the previous studies also makes use of the Fuzzy TOPSIS model to appraise the quality of service on a travel website. According to Kabir & Hasin (2012), the travel website provided several services for their customers, including travel information and product through the internet. Internet users are troubled by numerous travel websites where their qualities are questionable and vague. In this study, Kabir & Hasin (2012) proposed the Fuzzy TOPSIS method to illustrate a practical application from five travel agencies' websites are referenced as WA_1, WA_2, WA_3, WA_4, and WA_5. The method proposed by the research is able to help to find the best website of travel agencies which offer the topmost quality. Finally, the result shows that WA_2 is ranked at the first place and has the highest closeness coefficient, which is 0.2358 while WA_5 is ranked at the last place with a 0.1363 closeness coefficient.

2.3 The Development of Fuzzy Multi-Attribute Decision Making Model

According to Irvanizam (2017), Multi-Attribute Decision Making (MADM) method should be seen as a tool that evaluates several attributes simultaneously, with different weights and thresholds. It also has the ability to rely on a very satisfactory degree of ambiguous committee preferences. Throughout Iryanizam's analysis, he used one of these methods to select the candidates for a Simple Additive Weighting (SAW) scholarship. The SAW method is simple, and its calculation can be performed using a simple programming language. This method is suitable for comparing the characteristics and ability to solve the selection issue. The study chose seven out of ten students at Syiah Kuala University and then ranked them according to their Academic Achievement and Financial Aid Scholarships' university policy. Apart from that, Kurniawan et al. (2019) also applied Fuzzy Multiple Attribute Decision Making (FMADM) with the SAW method. The method which was used in this study determined the students' performance for receiving the scholarship. This decision support system was used as a solution to the problem in determining the scholarship, with a simple flow of algorithms.

Another research has been done by Puspitasari et al. (2017). They used the Analytic Hierarchy Process (AHP) model to evaluate the selection of scholarships at the Senior High School in East Java. It was difficult to determine the selection of scholarships in this high school; hence, this application must resolve the problem. In this study, the researchers built the system using the AHP method to solve complex and unstructured data into its group, inputs numerical values, and organises the groups into hierarchical order. The accuracy of the system for this research is 90%. By using the system, the method assisted teachers process and rank the scholarship recipients among students in a short time.

The preference selection index in the decision support system to determine education scholarship recipients has been done by Mesran et al. (2017). The study developed the Preference Selection Index (PSI) approach to solve the Multi-Criteria Decision Approach (MCDM). The use of this method provides more ease in selecting the scholarship's recipients. This method was easy and provided convenience to the decision-maker without assigning a weighted value to each alternative to avoid each alternative's relative importance.

According to Hajjah et al. (2018), in their research, the researchers combined two models to select scholarship candidates: the TOPSIS model and the AHP model. This research utilised these two models to select the scholarship recipients for the Junior High School level in the Education and Culture Office of Pekanbaru, Indonesia. The combination of the AHP and TOPSIS model has its respective accuracy according to the standard weights used. In comparison, the TOPSIS model is used to rank the students, who are recommended to get a scholarship from the Education and Culture Office of Pekanbaru. As a result, the AHP and TOPSIS model assisted the Education and Culture Office of Pekanbaru in selecting eligible students to get scholarships. In a nutshell, it can become an alternative decision-making solution in determining scholarship recipients.

CHAPTER 3

RESEARCH METHODOLOGY

This part will discuss thoroughly the methodology and approach for determining and selecting the scholarship recipients among students in Universiti Teknologi MARA (UiTM) Perlis using Fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

3.1 Method of Data Collection

This study is conducted to determine scholarship recipients among students. It will use the data taken from 30 students of UiTM Perlis. The researcher used primary data obtained from a set of questionnaires made using Google Forms. The questionnaires are in the form of open-ended questions that comprises of four (4) questions regarding the criteria, which are family income (C1), Grade Point Average (C2), the number of dependents in the family (C3), and the number of involvements in associations or activities in university (C4). There are 30 sets of questionnaires distributed to these 30 students of UiTM Perlis. The data collected were taken two days from 20th October 2020 until 21st October 2020 to get the complete data from respondents. The decision-maker is appointed to evaluate the importance of each criterion's weight.

3.2 Method of Data Analysis

In order to determine the rightful scholarship recipients among these 30 university students, the researcher use a few methods to complete this study. The first step for this study is to handle the vagueness of the criteria so that the researcher can formulate a model. Hence, the researcher decided to use fuzzy theory. Afterwards, the Fuzzy Multi-Attribute Decision Making (FMADM) with The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method will be used to rank the best alternative among all alternatives. Hwang and Yoon (1981) first introduced the fuzzy TOPSIS model, and later it was developed by Chen and Hwang (1992). Therefore, the fuzzy TOPSIS model is adopted to rank the best alternative, selecting the suitable scholarships' grantees to receive the scholarship.

3.2.1 Fuzzy Set Theory

In order to make the decision making a quick process, the fuzzy set theory method will handle the vagueness of the criteria. This method is one of the most preferred theories in the decision-making problem (Irvanizam, 2018). This theory is used for handling indecision or uncertainty and inaccurate information correlated with another. This study will use a triangular fuzzy number (TFN). TFN is one of the fuzzy number forms that can be used to handle the vagueness of the criteria which are family income (C1), Grade Point Average (C2), the number of dependents in the family (C3), and the number of involvements in associations or activities in university (C4). The membership function $\mu_{(A)}(x)$ of the triangular fuzzy number may be defined by a triplet (a_1, a_2, a_3) as in Equation (3.1).

$$\mu_{(A)}(x) = \begin{cases} 0, & x < a_1 \\ \frac{x-a_1}{a_2-a_1}, & a_1 \le x \le a_2 \\ \frac{a_3-x}{a_3-a_2}, & a_2 \le x \le a_3 \\ 0, & x > a_3 \end{cases} \tag{3.1}$$

where x represents an infinite set and A represents the triangular fuzzy number defined by triplet which are a_1, a_2, a_3.

The decision-maker used the linguistic variables to evaluate the importance of the weight for each criterion. The linguistic variables from the study conducted by Ece and Uludag (2017) will be used and better corresponding triangular fuzzy numbers are determined to assess the importance weight of each criterion, as shown in Table 3.1.

Table 3.1: Linguistic variables and corresponding triangular fuzzy numbers

Linguistic variable	Membership function	Domain	Triangular fuzzy number
Very Low (VL)	$\mu_{(A)}(x) = \frac{(0.1 - x)}{(0.1 - 0)}$	$0 \le x \le 0.1$	0,0,0.1
Low (L)	$\mu_{(A)}(x) = \frac{(x - 0)}{(0.1 - 0)}$ $\mu_{(A)}(x) = \frac{(0.3 - x)}{(0.3 - 0.1)}$	$0 \le x \le 0.1$ $0.1 \le x \le 0.3$	0,0.1,0.3
Medium Low (ML)	$\mu_{(A)}(x) = \frac{(x - 0.1)}{(0.3 - 0.1)}$ $\mu_{(A)}(x) = \frac{(0.5 - x)}{(0.5 - 0.3)}$	$0.1 \le x \le 0.3$ $0.3 \le x \le 0.5$	0.1,0.3,0.5
Medium (M)	$\mu_{(A)}(x) = \frac{(x - 0.3)}{(0.5 - 0.3)}$ $\mu_{(A)}(x) = \frac{(0.7 - x)}{(0.7 - 0.5)}$	$0.3 \le x \le 0.5$ $0.5 \le x \le 0.7$	0.3,0.5,0.7
Medium High (MH)	$\mu_{(A)}(x) = \frac{(x - 0.5)}{(0.7 - 0.5)}$ $\mu_{(A)}(x) = \frac{(0.9 - x)}{(0.9 - 0.7)}$	$0.5 \le x \le 0.7$ $0.7 \le x \le 0.9$	0.5,0.7,0.9
High (H)	$\mu_{(A)}(x) = \frac{(x - 0.7)}{(0.9 - 0.7)}$ $\mu_{(A)}(x) = \frac{(1.0 - x)}{(1.0 - 0.9)}$	$0.7 \le x \le 0.9$ $0.9 \le x \le 1.0$	0.7,0.9,1.0
Very High (VH)	$\mu_{(A)}(x) = \frac{(x - 0.9)}{(1 - 0.9)}$	$0.9 \le x \le 1.0$	0.9,1.0,1.0

The crisp number of triangular fuzzy number and normalised weight for the importance weight of each criterion can be defined as in Equation (3.2) and Equation (3.3).

$$\mu_{(A)}(x) = \frac{a_1 + a_2 + a_3}{3} \tag{3.2}$$

$$w_j = \frac{W_j}{\sum_{j=1}^{m} W_j} \tag{3.3}$$

where $\mu_{(A)}(x)$ represents the membership function of the triangular fuzzy number and w_j represents the value of weightage.

The crisp number of triangular fuzzy number and normalised weight can be calculated as follows:

Example: The crisp number of C1 using Equation (3.2).

$$\mu_{(A)}(x) = \frac{0.7 + 0.9 + 1.0}{3}$$

$$\mu_{(A)}(x) = 0.8667$$

Example: Normalised weight of C1 using Equation (3.3).

$$w_j = \frac{0.8667}{(0.8667 + 0.9667 + 0.5000 + 0.3000)}$$

$$w_j = 0.3291$$

3.2.2 Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

The TOPSIS method is used to solve the FMADM problem. The criteria used in this study are: family income (C1), Grade Point Average (C2), the number of dependents in the family (C3), and the number of involvements in associations or activities in the university (C4). TOPSIS will attempt to find an alternative for the shortest distance from the positive ideal solution (PIS) and the longest distance from the negative ideal solution (NIS). This method will rank the alternatives in descending order that supported the closeness coefficient representing the distances to PIS and NIS. There are six steps to reach the results or outputs. The process of Fuzzy TOPSIS is as follows.

Step 1: Fuzzy decision matrix D with m alternative and n criteria.

Students were defined as *m* alternative, A_i (*i=1, 2, 3, ..., m*) and the criteria were set as *n* attributes, C_j (*j= 1, 2, 3, ..., n*). The first step in Fuzzy TOPSIS is to construct a fuzzy decision matrix D with *m* alternative and *n* criteria, which can be described briefly as in Equation (3.4).

$$D = \begin{matrix} & C_1 & C_2 & C_3 & \cdots & C_n \\ A_1 & x_{11} & x_{12} & x_{13} & \cdots & x_{1n} \\ A_2 & x_{21} & x_{22} & x_{23} & \cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ A_m & x_{m1} & x_{m2} & x_{m3} & \cdots & x_{mn} \end{matrix} \quad (3.4)$$

where x_{ij} represents performance rating of *i*-th alternative; *i=1, 2,3, ..., m* with respect to the *j*-th criterion; *j=1, 2, 3, ..., n*.

Step 2: Normalised the decision matrix.

Build normalised the decision matrix *R* that is described in the Equation (3.5) and Equation (3.6) was explained on the calculation of normalising each element in matrix *D* in Equation (3.4).

$$R = \begin{matrix} & C_1 & C_2 & C_3 & \cdots & C_n \\ A_1 & r_{11} & r_{12} & r_{13} & \cdots & r_{1n} \\ A_2 & r_{21} & r_{22} & r_{23} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ A_m & r_{m1} & r_{m2} & r_{m3} & \cdots & r_{mn} \end{matrix} \quad (3.5)$$

$$r_{ij} = \frac{x_{ij}}{\sqrt{\left(\sum_{i=1}^{m} x_{ij}^2\right)}} \quad (3.6)$$

where r_{ij} represents normalised value.

For example, the normalised decision matrix for alternative 1 and criteria 1 by using Equation (3.6).

$$r_{11} = \frac{2}{\sqrt{2^2+1^2+2^2+1^2+1^2+3^2+3^2+4^2+1^2+2^2+1^2+4^2+5^2+5^2+1^2+1^2+3^2+1^2+1^2+4^2+4^2+4^2+3^2+5^2+2^2+2^2+3^2+3^2+5^2+1^2}}$$

$$r_{11} = \frac{2}{\sqrt{264}}$$

$$r_{11} = 0.1231$$

<u>Step 3: Weighted normalised matrix</u>

The decision-maker evaluated the weightage value using linguistic variables, as stated in Table 3.1. The decision-maker gave the importance weight for each criterion based on the table of linguistic variables. The weight was based on the level of importance of each criterion by prioritising the most important criteria as the requirements in selecting scholarship recipients. In this step, find the weighted normalised matrix V as in the Equation (3.7). The weighted normalised matrix can be calculated by multiplying two fuzzy numbers: the value of weightage and the value of each element from the normalised decision matrix, in step 2 by using Equation (3.8).

$$V = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{ccccc} C_1 & C_2 & C_3 & \cdots & C_n \end{array} \\ \begin{pmatrix} v_{11} & v_{12} & v_{13} & \cdots & v_{1n} \\ v_{21} & v_{22} & v_{23} & \cdots & v_{2n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ v_{m1} & v_{m2} & v_{m3} & \cdots & v_{mn} \end{pmatrix} \end{array} \qquad (3.7)$$

$$v_{ij} = w_j \times r_{ij} \qquad (3.8)$$

where w_j represents the value of weightage and r_{ij} represents the value of each element from the normalized decision matrix.

Example: Weighted normalised matrix for student 1 and criterion 1, which is family income by using Equation (3.8).

$$v_{11} = 0.3291 \times 0.1231$$

$$v_{11} = 0.0405$$

Step 4: The positive ideal solution (A^+) and the negative ideal solution (A^-).

Define the positive ideal solution (PIS), A^+; and the negative ideal solution (NIS), A^-; that can be calculated on the basis of weighted normalised rating using the Equation (3.9) and the Equation (3.10).

$$PIS = A^+ = \left\{ \underset{i}{Max}\, v_{ij}; j \in J \right\} = \{v_1^+, v_2^+, \dots, v_m^+\} \quad (3.9)$$

$$NIS = A^- = \left\{ \underset{i}{Min}\, v_{ij}; j \in J \right\} = \{v_1^-, v_2^-, \dots, v_m^-\} \quad (3.10)$$

where J is associated with benefit criteria.

Step 5: Measure the separation using Euclidean distance.

Calculate the measure of separation using the Euclidean distance. The separation of each alternative from PIS, D^+ can be calculated as shown in Equation (3.11).

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^+\right)^2}, 1 \le i \le m \quad (3.11)$$

Example: The calculation of separation measure of positive for student 1.

$$S_1 = \sqrt{(0.0405 - 0.1013)^2 + (0.0701 - 0.0740)^2 + (0.0406 - 0.0565)^2 + (0.0173 - 0.0535)^2}$$

$$S_1 = 0.0726$$

The separation for each alternative from NIS, D^- can be calculated as shown in Equation (3.12)

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^-\right)^2}, 1 \le i \le m \quad (3.12)$$

Example: The calculation for separation measure of negative for student 1.

$$S_1 = \sqrt{(0.0405 - 0.0203)^2 + (0.0701 - 0.0455)^2 + (0.0406 - 0.0081)^2 + (0.0173 - 0.0000)^2}$$

$$S_1 = 0.0487$$

Step 6: Compute the closeness coefficients of the alternative, CC^+ and rank the preference order of the alternative.

Find the relative closeness coefficients to the ideal solution, CC^+ from the separation of each alternative from PIS and NIS in step 5, which can be calculated as in Equation (3.13).

$$CC_i^+ = \frac{D_i^-}{D_i^- + D_i^+}, 1 \leq i \leq m \tag{3.13}$$

since $D_i^- \geq 0$ and $D_i^+ \geq 0$, then $CC_i^+ \in [0,1]$

The calculation of closeness coefficients of the alternative 1 for student 1 is shown by using Equation (3.13).

$$CC_1^+ = \frac{0.0487}{0.0487 + 0.0726}$$

$$CC_1^+ = 0.4014$$

After obtaining the result from calculating all the closeness coefficients of the alternative, the last step was to rank the preference order of the alternative in descending order. The highest value of closeness coefficients will be ranked as number 1, which is the best alternative. The selection of alternatives was based on the closeness coefficients. The alternatives who got more than 0.5 were qualified to get the scholarship, and the alternatives who got less than 0.5 were not fit to receive the scholarship.

CHAPTER 4

RESULTS AND DISCUSSION

This chapter will discuss the results from the data collection through questionnaires. The data for Fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method was calculated using Microsoft Excel.

4.1 Analysis of Results

This study was conducted through a survey using a questionnaire given to students in UiTM Perlis. The data collected were analysed in finding the ranking of students who fulfil the criteria to get the scholarship. The decision-maker was asked to use a linguistic variable to evaluate each criterion's importance in determining scholarship recipients. The objective is to find the best alternatives among scholarship recipients using the Fuzzy TOPSIS method. The results were generated from the Fuzzy Set Theory and the Fuzzy TOPSIS method. The data were analysed using Microsoft Excel and gathered into the tables. The results from the methods of the Fuzzy Set Theory and the Fuzzy TOPSIS were expressed in the tables as follows.

4.1.1 Fuzzy Set Theory

In this method, the linguistic variables, as shown in Table 3.1, were used by decision-makers to assess each criterion's importance weight. This linguistic variable is converted into fuzzy triangular numbers to construct the fuzzy decision matrix and determine each criterion's weight fuzzy number. Table 4.1 illustrates the importance of the weight of the criteria from decision-maker.

Table 4.1: Importance weight of the criteria from decision-maker.

Fuzzy Number				
Criteria	Linguistic Variable	Weight	Crisp Number	Normalised Weight
C1	VH	(0.7,0.9,1.0)	0.8667	0.3291
C2	EH	(0.9,1.0,1.0)	0.9667	0.3671
C3	M	(0.3,0.5,0.7)	0.5000	0.1899
C4	L	(0.1,0.3,0.5)	0.3000	0.1139

4.1.2 Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

The results are generated from the method of Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) using the steps given in Chapter 3. There are six steps in this method. The steps and results were expressed in Tables 4.2 until Tables 4.11.

Step 1: Fuzzy decision matrix D with m alternative and n criteria.

Table 4.2 shows the real data collected from the respondents. Table 4.4 demonstrated the collected data after change the income data into range number from Table 4.3. The alternative S represents the students, while attribute C represents the criteria. Criterion 1, which is family income, was classified into five classes since it has a significant value and replaces it in Table 4.4. Those classes are shown in Table 4.3.

Table 4.2: The Real Data

Alternative	C1	C2	C3	C4
S1	3500	3.74	5	5
S2	4100	3.52	3	8
S3	4000	3.62	6	2
S4	6000	3.60	2	5
S5	5000	3.80	1	4
S6	2400	3.81	3	2
S7	2800	3.49	6	2
S8	1800	3.82	3	13
S9	10000	3.68	3	4
S10	4000	2.43	5	5
S11	6000	3.79	2	2
S12	1500	3.79	4	3
S13	1000	3.27	7	1
S14	1000	3.55	5	0
S15	5600	3.91	6	8
S16	15000	2.57	4	1
S17	2080	3.35	2	6
S18	5600	3.91	6	8
S19	6400	3.95	4	11
S20	2000	3.20	2	6
S21	1800	3.82	2	15
S22	1100	3.08	3	3
S23	3000	3.73	6	3
S24	1000	3.74	3	5
S25	4000	3.52	5	4
S26	3500	3.70	4	3
S27	3000	3.50	2	0
S28	2500	3.84	3	5
S29	1000	3.50	6	4
S30	9000	3.53	6	0

Table 4.3: Family income range

Family Income	**Range**
0 – 1000	5
1000 – 2000	4
2000 – 3000	3
3000 – 4000	2
>4000	1

Table 4.4: The collected data

Alternative	**C1**	**C2**	**C3**	**C4**
S1	2	3.74	5	5
S2	1	3.52	3	8
S3	2	3.62	6	2
S4	1	3.60	2	5
S5	1	3.80	1	4
S6	3	3.81	3	2
S7	3	3.49	6	2
S8	4	3.82	3	13
S9	1	3.68	3	4
S10	2	2.43	5	5
S11	1	3.79	2	2
S12	4	3.79	4	3
S13	5	3.27	7	1
S14	5	3.55	5	0
S15	1	3.91	6	8
S16	1	2.57	4	1
S17	3	3.35	2	6
S18	1	3.91	6	8
S19	1	3.95	4	11
S20	4	3.20	2	6
S21	4	3.82	2	15
S22	4	3.08	3	3
S23	3	3.73	6	3
S24	5	3.74	3	5

S25	2	3.52	5	4
S26	2	3.70	4	3
S27	3	3.50	2	0
S28	3	3.84	3	5
S29	5	3.50	6	4
S30	1	3.53	6	0

Step 2: Normalised the decision matrix.

All the values were calculated into a normalised decision matrix using Equation (3.6). Table 4.5 shows the results of the calculation criteria matrix obtained results in the form of normalisation.

Table 4.5: Normalised decision matrix

Alternative	C1	C2	C3	C4
S1	0.1231	0.1909	0.2126	0.1564
S2	0.0615	0.1797	0.1276	0.2502
S3	0.1231	0.1848	0.2551	0.0626
S4	0.0615	0.1838	0.0850	0.1564
S5	0.0615	0.1940	0.0425	0.1251
S6	0.1846	0.1945	0.1276	0.0626
S7	0.1846	0.1782	0.2551	0.0626
S8	0.2462	0.1950	0.1276	0.4066
S9	0.0615	0.1879	0.1276	0.1251
S10	0.1231	0.1241	0.2126	0.1564
S11	0.0615	0.1935	0.0850	0.0626
S12	0.2462	0.1935	0.1701	0.0938
S13	0.3077	0.1669	0.2977	0.0313
S14	0.3077	0.1812	0.2126	0.0000
S15	0.0615	0.1996	0.2551	0.2502
S16	0.0615	0.1312	0.1701	0.0313
S17	0.1846	0.1710	0.0850	0.1877
S18	0.0615	0.1996	0.2551	0.2502
S19	0.0615	0.2017	0.1701	0.3441
S20	0.2462	0.1634	0.0850	0.1877

S21	0.2462	0.1950	0.0850	0.4692
S22	0.2462	0.1572	0.1276	0.0938
S23	0.1846	0.1904	0.2551	0.0938
S24	0.3077	0.1909	0.1276	0.1564
S25	0.1231	0.1797	0.2126	0.1251
S26	0.1231	0.1889	0.1701	0.0938
S27	0.1846	0.1787	0.0850	0.0000
S28	0.1846	0.1960	0.1276	0.1564
S29	0.3077	0.1787	0.2551	0.1251
S30	0.0615	0.1802	0.2551	0.0000

Step 3: Weighted normalised matrix

Each element of the normalised matrix will be multiplied with the weightage that was already obtained from the fuzzy set theory that had been assigned weight for each criterion according to linguistic variables. A weighted normalised matrix was then computed using Equation (3.8) and is shown in Table 4.6.

Table 4.6: Weighted normalised matrix and its weightage

Weightage	**0.3291**	**0.3671**	**0.1899**	**0.1139**
Alternative	**C1**	**C2**	**C3**	**C4**
S1	0.0405	0.0701	0.0404	0.0178
S2	0.0203	0.0660	0.0242	0.0285
S3	0.0405	0.0678	0.0484	0.0071
S4	0.0203	0.0675	0.0161	0.0178
S5	0.0203	0.0712	0.0081	0.0143
S6	0.0608	0.0714	0.0242	0.0071
S7	0.0608	0.0654	0.0484	0.0071
S8	0.0810	0.0716	0.0242	0.0463
S9	0.0203	0.0690	0.0242	0.0143
S10	0.0405	0.0455	0.0404	0.0178
S11	0.0203	0.0710	0.0161	0.0071
S12	0.0810	0.0710	0.0323	0.0107
S13	0.1013	0.0613	0.0565	0.0036

S14	0.1013	0.0665	0.0404	0.0000
S15	0.0203	0.0733	0.0484	0.0285
S16	0.0203	0.0482	0.0323	0.0036
S17	0.0608	0.0628	0.0161	0.0214
S18	0.0203	0.0733	0.0484	0.0285
S19	0.0203	0.0740	0.0323	0.0392
S20	0.0810	0.0600	0.0161	0.0214
S21	0.0810	0.0716	0.0161	0.0535
S22	0.0810	0.0577	0.0242	0.0107
S23	0.0608	0.0699	0.0484	0.0107
S24	0.1013	0.0701	0.0242	0.0178
S25	0.0405	0.0660	0.0404	0.0143
S26	0.0405	0.0693	0.0323	0.0107
S27	0.0608	0.0656	0.0161	0.0000
S28	0.0608	0.0720	0.0242	0.0178
S29	0.1013	0.0656	0.0484	0.0143
S30	0.0203	0.0662	0.0484	0.0000

Step 4: The positive ideal solution (A^+) and the negative ideal solution (A^-).

The positive ideal solution and the negative ideal solution were determined using Equation (3.9) and Equation (3.10). The result of this process is shown in Table 4.7.

Table 4.7: The positive ideal solution and the negative ideal solution

Alternative	C1	C2	C3	C4
Positive Ideal Solution (A^+)	0.1013	0.0740	0.0565	0.0535
Negative Ideal Solution (A^-)	0.0203	0.0455	0.0081	0.0000

Step 5: Measure the separation using Euclidean distance.

As shown in Table 4.8, the next step is the separation measure of positive and negative to determine the distance of each alternative. The separation measure of positive was calculated using Equation (3.11), and the separation measure of negative was calculated using Equation (3.12), and the results is shown in Table 4.8.

Table 4.8: The calculated result of the positive and negative using Euclidean distance

Alternative	**C1**	**C2**	**C3**	**C4**	**D^+**	**D^-**
S1	0.0405	0.0701	0.0406	0.0173	0.0726	0.0487
S2	0.0203	0.0660	0.0243	0.0278	0.0912	0.0381
S3	0.0405	0.0678	0.0487	0.0069	0.0772	0.0510
S4	0.0203	0.0675	0.0162	0.0173	0.0976	0.0291
S5	0.0203	0.0712	0.0081	0.0139	0.1024	0.0292
S6	0.0608	0.0714	0.0243	0.0069	0.0696	0.0512
S7	0.0608	0.0654	0.0487	0.0069	0.0628	0.0611
S8	0.0810	0.0716	0.0242	0.0463	0.0389	0.0823
S9	0.0203	0.0690	0.0243	0.0139	0.0959	0.0317
S10	0.0405	0.0455	0.0406	0.0173	0.0779	0.0420
S11	0.0203	0.0710	0.0162	0.0069	0.1018	0.0276
S12	0.0810	0.0710	0.0324	0.0104	0.0534	0.0710
S13	0.1013	0.0613	0.0568	0.0035	0.0516	0.0959
S14	0.1013	0.0665	0.0406	0.0000	0.0563	0.0898
S15	0.0203	0.0733	0.0487	0.0278	0.0854	0.0565
S16	0.0203	0.0482	0.0324	0.0035	0.1015	0.0248
S17	0.0608	0.0628	0.0162	0.0208	0.0668	0.0494
S18	0.0203	0.0733	0.0487	0.0278	0.0854	0.0565
S19	0.0203	0.0740	0.0324	0.0382	0.0859	0.0535
S20	0.0810	0.0600	0.0162	0.0208	0.0574	0.0663
S21	0.0810	0.0716	0.0162	0.0520	0.0452	0.0845
S22	0.0810	0.0577	0.0243	0.0104	0.0597	0.0649
S23	0.0608	0.0699	0.0487	0.0104	0.0598	0.0632
S24	0.1013	0.0701	0.0243	0.0173	0.0485	0.0879
S25	0.0405	0.0660	0.0406	0.0139	0.0747	0.0456
S26	0.0405	0.0693	0.0324	0.0104	0.0784	0.0410
S27	0.0608	0.0656	0.0162	0.0000	0.0787	0.0459
S28	0.0608	0.0720	0.0243	0.0173	0.0631	0.0539

S29	0.1013	0.0656	0.0487	0.0139	0.0412	0.0938
S30	0.0203	0.0662	0.0487	0.0000	0.0977	0.0455

Step 6: Compute the closeness coefficients of the alternative, CC^+ and rank the preference order of the alternative.

The closeness of each alternative is then calculated using Equation (3.13). The closeness's maximum value shows that the best alternatives are preferred to get the scholarship. The findings show the result of the ranks of 30 students from the closeness coefficients of each alternative in Table 4.9.

Table 4.9: Closeness coefficients of the alternative

Alternative	D^+	D^-	CC^+	Rank
S1	0.0726	0.0487	0.4014	15
S2	0.0912	0.0381	0.2946	25
S3	0.0772	0.0510	0.3980	18
S4	0.0976	0.0291	0.2297	27
S5	0.1024	0.0292	0.2218	28
S6	0.0696	0.0512	0.4238	14
S7	0.0628	0.0611	0.4932	11
S8	0.0389	0.0823	0.6793	2
S9	0.0959	0.0317	0.2486	26
S10	0.0779	0.0420	0.3505	22
S11	0.1018	0.0276	0.2136	29
S12	0.0534	0.0710	0.5708	7
S13	0.0516	0.0959	0.6502	4
S14	0.0563	0.0898	0.6146	6
S15	0.0854	0.0565	0.3981	16
S16	0.1015	0.0248	0.1960	30
S17	0.0668	0.0494	0.4252	13
S18	0.0854	0.0565	0.3981	16
S19	0.0859	0.0535	0.3838	19
S20	0.0574	0.0663	0.5360	8
S21	0.0452	0.0845	0.6517	3

S22	0.0597	0.0649	0.5209	9
S23	0.0598	0.0632	0.5138	10
S24	0.0485	0.0879	0.6444	5
S25	0.0747	0.0456	0.3789	20
S26	0.0784	0.0410	0.3432	23
S27	0.0787	0.0459	0.3685	21
S28	0.0631	0.0539	0.4606	12
S29	0.0412	0.0938	0.6948	1
S30	0.0977	0.0455	0.3179	24

The students' qualification to get the scholarship has been set from closeness coefficients to the ideal solution. Alternatives who obtained a result of more than 0.5 were chosen to get the scholarship. Table 4.10 reveals the range of qualifications set to get the scholarship.

Table 4.10: Range of qualification that has been set to get scholarship

Qualification to receive the scholarship that has been set from closeness to ideal solution	
Qualified	>0.5
Not Qualified	<0.5

Table 4.11: Final results for determining scholarship recipients

Alternative	**CC⁺**	**Rank**	**Decision**
S1	0.4014	15	Not Qualified
S2	0.2946	25	Not Qualified
S3	0.3980	18	Not Qualified
S4	0.2297	27	Not Qualified
S5	0.2218	28	Not Qualified
S6	0.4238	14	Not Qualified
S7	0.4932	11	Not Qualified
S8	0.6793	2	Qualified
S9	0.2486	26	Not Qualified
S10	0.3505	22	Not Qualified
S11	0.2136	29	Not Qualified

S12	0.5708	7	Qualified
S13	0.6502	4	Qualified
S14	0.6146	6	Qualified
S15	0.3981	16	Not Qualified
S16	0.1960	30	Not Qualified
S17	0.4252	13	Not Qualified
S18	0.3981	16	Not Qualified
S19	0.3838	19	Not Qualified
S20	0.5360	8	Qualified
S21	0.6517	3	Qualified
S22	0.5209	9	Qualified
S23	0.5138	10	Qualified
S24	0.6444	5	Qualified
S25	0.3789	20	Not Qualified
S26	0.3432	23	Not Qualified
S27	0.3685	21	Not Qualified
S28	0.4606	12	Not Qualified
S29	0.6948	1	Qualified
S30	0.3179	24	Not Qualified

Finally, Table 4.11 shows the final results for determining the scholarship recipients among UiTM Perlis students. There are ten (10) students qualified to get the scholarship. The first student who is qualified to receive the scholarship is S29 and followed by S8, S21, S13, S24, S14, S12, S20, S22, and S23. The other remaining candidates are not qualified to receive the scholarship as their result did not meet the scholarship requirements.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This chapter present the summary and conclusion of the research. The author will propose some recommendations for the benefits of future researchers who are interested to examine further in this field.

5.1 Conclusion

This study has demonstrated the Fuzzy Multi-Attribute Decision Making (FMADM) with Technique for Order of Preferences by Similarity to Ideal Solution (TOPSIS) to determine the ideal scholarship recipients between 30 students of UiTM Perlis based on linguistic variables and crisp values. The decision-maker uses the linguistic variables and crisp values to assign the criteria weight of each criterion. In this study, four criteria were used. There are family income, Grade Point Average (GPA), the number of dependents in the family, and the number of involvements in associations or activities in the university. Hence, the researcher had used Microsoft Excel software to analyse the data and successfully achieved the results.

This study aims to rank and determine the best alternative among scholarship recipients and decide which students are qualified to receive the scholarship. The finding shows that ten (10) students are fitted to get scholarships. This is because their result has passed the qualification to get the scholarship set by closeness coefficient, which is 0.5 and above. The first student who is the most eligible to receive the scholarship is S29 and followed by S8, S21, S13, S24, S14, S12, S20, S22, and S23. It shows that S29 is the best alternative with a 0.6948 closeness coefficient generated through this method. Meanwhile, S16 is the worst alternative and the most unlikely candidate to receive the scholarship with a 0.1960 closeness coefficient. It concludes that S16 is not qualified to receive the scholarship since he/she does not fulfil the qualified range to receive the scholarship.

Hence, by using this method, the selection process's mistakes will be reduced compared to manual selection. Therefore, it is proven that the results can be obtained swiftly using this approach.

5.2 Recommendation

During the process of completing this study, there are several limitations that the researcher came across. For instance, this study still use decision-maker to assign each criterion's criteria weight. The result that is obtained from this study will be more accurate and better by adding more other criteria. The number of criteria used will affect the accuracy of the results of selecting the scholarship recipients. The result would be better by adding criteria for future researches such as the number of credit points obtained, level of study, and the number of siblings in order to acquire accurate and better results. However, this study can be used to help future researchers as their references in decision-making problems and gain better results in the future. Besides, multi-attribute decision making can be solved using other methods instead of the TOPSIS method. The other methods that may be implemented in multi-attribute decision making in deciding scholarship recipients are the Simple Additive Weighting Method (SAW) and Weighted Product Method (WPM).

REFERENCES

Anamisa, D. R., Rachmad, A., Putro, S. S., Jauhari, A., Khozaimi, A., Pujiastutik, R., & Rahmanita, E. (2018). The Selection System of Student Scholarship Based on Simple Additive Weighting and Technique for Order Preference by Similarity to Ideal Solution Method. *International Conference on Computer Science and Engineering Technology (ICCSET)*, 24-29.

Ariapour, A., Veisanloo, F., & Asgari, M. (2014). An Application of Fuzzy TOPSIS Method for Plant Selection in Rangeland Improvement (Case Study: Boroujerd Rangeland, Lorestan Province, Iran). *Journal of Rangeland Science*, 183-194.

Azizi, A., Aikhuele, D. O., & Souleman, F. S. (2015). A Fuzzy TOPSIS Model to Rank Automotive Suppliers. *Procedia Manufacturing*, 159-164.

Digalwar, A. K. (2018). Application of Fuzzy TOPSIS for evaluating machining techniques using sustainability metrics. *IOP Conference Series: Materials Science and Engineering* (p. 346). Pilani: IOP Publishing.

Ece, U. (2017). Applicability of fuzzy TOPSIS method in optimal portfolio selection and an application in BIST . *International Journal of Economics and Finance*, 107-127.

Fathi, M. R., Matin, H. Z., Zarchi, M. K., & Azizollahi, S. (2011). The Application of Fuzzy TOPSIS Approach to Personnel Selection for Padir Company, Iran. *Journal of management Research*, 1-14.

Hajjah, A., Gusrianty, Setepen, & Oktarina, D. (2018). Decision Support System To Recommend Scholarships Using AHP TOPSIS Methods In Education And Culture Office Of Pekanbaru. *American Journal of Engineering Research (AJER)*, 61-67.

Irvanizam, I. (2017). Multiple Attribute Decision Making with Simple Additive Weighting Approach for Selecting the Scholarship Recipients at Syiah Kuala

University. *International Conference on Electrical Engineering and Informatics (ICELTICs 2017)*, 245-250.

Irvanizam, I. (2018). Application of the fuzzy topsis multi-attribute decision making method to determine scholarship recipients. *Journal of Physics: Conference Series* (Vol. 978, No. 1, p. 012056). Aceh: IOP Publishing.

Kabir, G., & Hasin, M. A. (2012). Comparative Analysis of TOPSIS and Fuzzy TOPSIS for The Evaluation of Travel Website Service Quality. *International Journal for Quality Research*, 169-185.

Kurniawan, H., Swondo, A. P., Sari, E. P., Ummi, K., & Agustin, F. (2019). Decision Support System To Determine The Student Achievement Scholarship Recipients Using Fuzzy Multi Attribute Decision Making (FMADM) With SAW. *2019 7th International Conference on Cyber and IT Service Management (CITSM)*, 1-6.

Madi, E. N., Garibaldi, J. M., & Wagner, C. (2015). A comparison between two types of Fuzzy TOPSIS method. *IEEE International Conference on Systems, Man, and Cybernetics*. Nottingham: Institute of Electrical and Electronics Engineers (IEEE). (pp. 291-297). IEEE.

Maseleno, A., Sugiyarti, E., Jasmi, K. A., Basiron, B., Huda, M., & K., S. (2018). Decision Support System of Scholarship Grantee Selection Using Data Mining. *International Journal of Pure and Applied Mathematics*, 2239-2249.

Mesran, Tampubolon, K., Sianturi, R. D., Waruwu, F. T., & Siahaan, A. P. (2017). Determination of Education Scholarship Recipients Using Preference Selection Index. *International Journal of Scientific Research in Science and Technology (IJSRST)*, 230-234.

Omeje, A. N., & Abugu, S. O. (2015). The Impact of Scholarships on Student's Academic Performance: A Case pf Tertiary Institutions in Enugu State, Nigera. *Bulletin of Business and Economics*, 93-104.

Puspitasari, T. D., Sari, E. O., Destarianto, P., & Riskiawan, H. Y. (2018). Decision Support System for Determining Scholarship Selection using an Analytical Hierarchy Process. *Journal of Physics: Conference Series* (Vol. 953, No. 1, p. 012119). Surabaya: IOP Publishing.

Saragih, H., Marbun, M., & Reza, B. (2013). Development of Decision Support System Determining The Student as Scholarship Recipients by Fuzzy Multi Attribute Decision Making (FMADM). *Journal of Information Systems*, 75-81.

Shamshuritawi Shahrif, S. I. (2015). Bea Scoring System: Selecting the Right Person for Scholarship. *International Journal of Economics and Financial Issues*, 242-246.

Wimatsari, G. A., Putra, K. G., & Buana, P. W. (2013). Multi-Attribute Decision Making Scholarship Selection Using A Modified Fuzzy TOPSIS. *International Journal of Computer Science Issues (IJCSI)*, 309-317.

Appendix A: Questionnaire

Final Year Project

I am a student from the Bachelor of Science (Hons.) Management Mathematics (CS248) currently doing my final year project with the title of Determining scholarship recipients among students of UiTM Perlis. I really need your help to answer this survey. The information provided will help me in conducting my project. I really appreciate it if you could take a few seconds to answer the following questions. Thank you in advance.

Family Income (RM) *

Short-answer text

Grade Point Average (Last Semester) *

Short-answer text

The number of dependents in the family *

Short-answer text

How many times in the last semester did you involve in associations or activities in university? (Estimate) *

Short-answer text

Appendix B: Data Analysis

Analysis of Fuzzy Multi-Attribute Decision Making with TOPSIS

4 Criteria:
1. Family Income (C1)
2. Grade Point Average (C2)
3. Number of Dependents (C3)
4. Involvement in Associations or Activities (C4)

Normalized Weight				
C1	C2	C3	C4	TOTAL
0.3291	0.3671	0.1899	0.1139	1

The data collected from student of UiTM Perlis.

Alternative	**C1**	**C2**	**C3**	**C4**
S1	3500	3.74	5	5
S2	4100	3.52	3	8
S3	4000	3.62	6	2
S4	6000	3.6	2	5
S5	5000	3.8	1	4
S6	2400	3.81	3	2
S7	2800	3.49	6	2
S8	1800	3.82	3	13
S9	10000	3.68	3	4
S10	4000	2.43	5	5
S11	6000	3.79	2	2
S12	1500	3.79	4	3
S13	1000	3.27	7	1
S14	1000	3.55	5	0
S15	5600	3.91	6	8

The range of family income (C1)

Family Income	**Range**
0 - 1000	5
1000 - 2000	4
2000 - 3000	3
3000 - 4000	2
> 4000	1

S16	15000	2.57	4	1
S17	2080	3.35	2	6
S18	5600	3.91	6	8
S19	6400	3.95	4	11
S20	2000	3.2	2	6
S21	1800	3.82	2	15
S22	1100	3.08	3	3
S23	3000	3.73	6	3
S24	1000	3.74	3	5
S25	4000	3.52	5	4
S26	3500	3.7	4	3
S27	3000	3.5	2	0
S28	2500	3.84	3	5
S29	1000	3.5	6	4
S30	9000	3.53	6	0

Step 1: Construct a fuzzy decision matrix D with m alternative and n criteria.

Alternative	**C1**	**C2**	**C3**	**C4**
S1	2	3.74	5	5
S2	1	3.52	3	8
S3	2	3.62	6	2
S4	1	3.6	2	5
S5	1	3.8	1	4
S6	3	3.81	3	2
S7	3	3.49	6	2
S8	4	3.82	3	13

S9	1	3.68	3	4
S10	2	2.43	5	5
S11	1	3.79	2	2
S12	4	3.79	4	3
S13	5	3.27	7	1
S14	5	3.55	5	0
S15	1	3.91	6	8
S16	1	2.57	4	1
S17	3	3.35	2	6
S18	1	3.91	6	8
S19	1	3.95	4	11
S20	4	3.2	2	6
S21	4	3.82	2	15
S22	4	3.08	3	3
S23	3	3.73	6	3
S24	5	3.74	3	5
S25	2	3.52	5	4
S26	2	3.7	4	3
S27	3	3.5	2	0
S28	3	3.84	3	5
S29	5	3.5	6	4
S30	1	3.53	6	0

Step 2: Build normalised the decision matrix R.

Squared				
Alternative	C1	C2	C3	C4
S1	4	13.9876	25	25
S2	1	12.3904	9	64
S3	4	13.1044	36	4
S4	1	12.9600	4	25
S5	1	14.4400	1	16
S6	9	14.5161	9	4
S7	9	12.1801	36	4
S8	16	14.5924	9	169
S9	1	13.5424	9	16
S10	4	5.9049	25	25
S11	1	14.3641	4	4
S12	16	14.3641	16	9
S13	25	10.6929	49	1
S14	25	12.6025	25	0
S15	1	15.2881	36	64
S16	1	6.6049	16	1
S17	9	11.2225	4	36
S18	1	15.2881	36	64
S19	1	15.6025	16	121
S20	16	10.2400	4	36
S21	16	14.5924	4	225
S22	16	9.4864	9	9
S23	9	13.9129	36	9
S24	25	13.9876	9	25

Alternative	C1	C2	C3	C4
S1	0.1231	0.1909	0.2126	0.1564
S2	0.0615	0.1797	0.1276	0.2502
S3	0.1231	0.1848	0.2551	0.0626
S4	0.0615	0.1838	0.0850	0.1564
S5	0.0615	0.1940	0.0425	0.1251
S6	0.1846	0.1945	0.1276	0.0626
S7	0.1846	0.1782	0.2551	0.0626
S8	0.2462	0.1950	0.1276	0.4066
S9	0.0615	0.1879	0.1276	0.1251
S10	0.1231	0.1241	0.2126	0.1564
S11	0.0615	0.1935	0.0850	0.0626
S12	0.2462	0.1935	0.1701	0.0938
S13	0.3077	0.1669	0.2977	0.0313
S14	0.3077	0.1812	0.2126	0.0000
S15	0.0615	0.1996	0.2551	0.2502
S16	0.0615	0.1312	0.1701	0.0313
S17	0.1846	0.1710	0.0850	0.1877
S18	0.0615	0.1996	0.2551	0.2502
S19	0.0615	0.2017	0.1701	0.3441
S20	0.2462	0.1634	0.0850	0.1877
S21	0.2462	0.1950	0.0850	0.4692
S22	0.2462	0.1572	0.1276	0.0938
S23	0.1846	0.1904	0.2551	0.0938
S24	0.3077	0.1909	0.1276	0.1564

S25	4	12.3904	25	16
S26	4	13.6900	16	9
S27	9	12.2500	4	0
S28	9	14.7456	9	25
S29	25	12.2500	36	16
S30	1	12.4609	36	0

S25	0.1231	0.1797	0.2126	0.1251
S26	0.1231	0.1889	0.1701	0.0938
S27	0.1846	0.1787	0.0850	0.0000
S28	0.1846	0.1960	0.1276	0.1564
S29	0.3077	0.1787	0.2551	0.1251
S30	0.0615	0.1802	0.2551	0.0000

Step 3: Find the weighted normalised matrix V.

Alternative	C1	C2	C3	C4
S1	0.0405	0.0701	0.0404	0.0178
S2	0.0203	0.0660	0.0242	0.0285
S3	0.0405	0.0678	0.0484	0.0071
S4	0.0203	0.0675	0.0161	0.0178
S5	0.0203	0.0712	0.0081	0.0143
S6	0.0608	0.0714	0.0242	0.0071
S7	0.0608	0.0654	0.0484	0.0071
S8	0.0810	0.0716	0.0242	0.0463
S9	0.0203	0.0690	0.0242	0.0143
S10	0.0405	0.0455	0.0404	0.0178
S11	0.0203	0.0710	0.0161	0.0071
S12	0.0810	0.0710	0.0323	0.0107
S13	0.1013	0.0613	0.0565	0.0036
S14	0.1013	0.0665	0.0404	0.0000
S15	0.0203	0.0733	0.0484	0.0285
S16	0.0203	0.0482	0.0323	0.0036
S17	0.0608	0.0628	0.0161	0.0214
S18	0.0203	0.0733	0.0484	0.0285

S19	0.0203	0.0740	0.0323	0.0392
S20	0.0810	0.0600	0.0161	0.0214
S21	0.0810	0.0716	0.0161	0.0535
S22	0.0810	0.0577	0.0242	0.0107
S23	0.0608	0.0699	0.0484	0.0107
S24	0.1013	0.0701	0.0242	0.0178
S25	0.0405	0.0660	0.0404	0.0143
S26	0.0405	0.0693	0.0323	0.0107
S27	0.0608	0.0656	0.0161	0.0000
S28	0.0608	0.0720	0.0242	0.0178
S29	0.1013	0.0656	0.0484	0.0143
S30	0.0203	0.0662	0.0484	0.0000

Step 4: Define the positive ideal solution (PIS), A^+; and the negative ideal solution (NIS), A^- that can be calculated on the basis of weighted normalised rating.

PIS and NIS	**C1**	**C2**	**C3**	**C4**
PIS(A^+)	0.1013	0.0740	0.0565	0.0535
NIS(A^-)	0.0203	0.0455	0.0081	0.0000

Step 5: Calculate the measure of separation using the Euclidean distance.

Alternative	**C1**	**C2**	**C3**	**C4**	**D^+**	**D^-**
S1	0.0405	0.0701	0.0406	0.0173	0.0726	0.0487
S2	0.0203	0.0660	0.0243	0.0278	0.0912	0.0381
S3	0.0405	0.0678	0.0487	0.0069	0.0772	0.0510
S4	0.0203	0.0675	0.0162	0.0173	0.0976	0.0291
S5	0.0203	0.0712	0.0081	0.0139	0.1024	0.0292
S6	0.0608	0.0714	0.0243	0.0069	0.0696	0.0512

S7	0.0608	0.0654	0.0487	0.0069	0.0628	0.0611
S8	0.0810	0.0716	0.0242	0.0463	0.0389	0.0823
S9	0.0203	0.0690	0.0243	0.0139	0.0959	0.0317
S10	0.0405	0.0455	0.0406	0.0173	0.0779	0.0420
S11	0.0203	0.0710	0.0162	0.0069	0.1018	0.0276
S12	0.0810	0.0710	0.0324	0.0104	0.0534	0.0710
S13	0.1013	0.0613	0.0568	0.0035	0.0516	0.0959
S14	0.1013	0.0665	0.0406	0.0000	0.0563	0.0898
S15	0.0203	0.0733	0.0487	0.0278	0.0854	0.0565
S16	0.0203	0.0482	0.0324	0.0035	0.1015	0.0248
S17	0.0608	0.0628	0.0162	0.0208	0.0668	0.0494
S18	0.0203	0.0733	0.0487	0.0278	0.0854	0.0565
S19	0.0203	0.0740	0.0324	0.0382	0.0859	0.0535
S20	0.0810	0.0600	0.0162	0.0208	0.0574	0.0663
S21	0.0810	0.0716	0.0162	0.0520	0.0452	0.0845
S22	0.0810	0.0577	0.0243	0.0104	0.0597	0.0649
S23	0.0608	0.0699	0.0487	0.0104	0.0598	0.0632
S24	0.1013	0.0701	0.0243	0.0173	0.0485	0.0879
S25	0.0405	0.0660	0.0406	0.0139	0.0747	0.0456
S26	0.0405	0.0693	0.0324	0.0104	0.0784	0.0410
S27	0.0608	0.0656	0.0162	0.0000	0.0787	0.0459
S28	0.0608	0.0720	0.0243	0.0173	0.0631	0.0539
S29	0.1013	0.0656	0.0487	0.0139	0.0412	0.0938
S30	0.0203	0.0662	0.0487	0.0000	0.0977	0.0455

Step 6: Find the relative closeness to the ideal solution.

Alternative	C1	C2	C3	C4	D^+	D^-	CC^+
S1	0.0405	0.0701	0.0406	0.0173	0.0726	0.0487	0.4014
S2	0.0203	0.0660	0.0243	0.0278	0.0912	0.0381	0.2946
S3	0.0405	0.0678	0.0487	0.0069	0.0772	0.0510	0.3980
S4	0.0203	0.0675	0.0162	0.0173	0.0976	0.0291	0.2297
S5	0.0203	0.0712	0.0081	0.0139	0.1024	0.0292	0.2218
S6	0.0608	0.0714	0.0243	0.0069	0.0696	0.0512	0.4238
S7	0.0608	0.0654	0.0487	0.0069	0.0628	0.0611	0.4932
S8	0.0810	0.0716	0.0242	0.0463	0.0389	0.0823	0.6793
S9	0.0203	0.0690	0.0243	0.0139	0.0959	0.0317	0.2486
S10	0.0405	0.0455	0.0406	0.0173	0.0779	0.0420	0.3505
S11	0.0203	0.0710	0.0162	0.0069	0.1018	0.0276	0.2136
S12	0.0810	0.0710	0.0324	0.0104	0.0534	0.0710	0.5708
S13	0.1013	0.0613	0.0568	0.0035	0.0516	0.0959	0.6502
S14	0.1013	0.0665	0.0406	0.0000	0.0563	0.0898	0.6146
S15	0.0203	0.0733	0.0487	0.0278	0.0854	0.0565	0.3981
S16	0.0203	0.0482	0.0324	0.0035	0.1015	0.0248	0.1960
S17	0.0608	0.0628	0.0162	0.0208	0.0668	0.0494	0.4252
S18	0.0203	0.0733	0.0487	0.0278	0.0854	0.0565	0.3981
S19	0.0203	0.0740	0.0324	0.0382	0.0859	0.0535	0.3838
S20	0.0810	0.0600	0.0162	0.0208	0.0574	0.0663	0.5360
S21	0.0810	0.0716	0.0162	0.0520	0.0452	0.0845	0.6517
S22	0.0810	0.0577	0.0243	0.0104	0.0597	0.0649	0.5209
S23	0.0608	0.0699	0.0487	0.0104	0.0598	0.0632	0.5138
S24	0.1013	0.0701	0.0243	0.0173	0.0485	0.0879	0.6444
S25	0.0405	0.0660	0.0406	0.0139	0.0747	0.0456	0.3789

S26	0.0405	0.0693	0.0324	0.0104	0.0784	0.0410	0.3432
S27	0.0608	0.0656	0.0162	0.0000	0.0787	0.0459	0.3685
S28	0.0608	0.0720	0.0243	0.0173	0.0631	0.0539	0.4606
S29	0.1013	0.0656	0.0487	0.0139	0.0412	0.0938	0.6948
S30	0.0203	0.0662	0.0487	0.0000	0.0977	0.0455	0.3179

Step 7: Rank the preference order of the alternative in descending order and find the qualification.

Qualification that has been set:	
Qualified	>0.5
Not Qualified	<0.5

Alternative	**C1**	**C2**	**C3**	**C4**	**D^+**	**D^-**	**CC^+**	**Rank**	**Qualification**
S1	0.0405	0.0701	0.0406	0.0173	0.0726	0.0487	0.4014	15	Not Qualified
S2	0.0203	0.0660	0.0243	0.0278	0.0912	0.0381	0.2946	25	Not Qualified
S3	0.0405	0.0678	0.0487	0.0069	0.0772	0.0510	0.3980	18	Not Qualified
S4	0.0203	0.0675	0.0162	0.0173	0.0976	0.0291	0.2297	27	Not Qualified
S5	0.0203	0.0712	0.0081	0.0139	0.1024	0.0292	0.2218	28	Not Qualified
S6	0.0608	0.0714	0.0243	0.0069	0.0696	0.0512	0.4238	14	Not Qualified
S7	0.0608	0.0654	0.0487	0.0069	0.0628	0.0611	0.4932	11	Not Qualified
S8	0.0810	0.0716	0.0242	0.0463	0.0389	0.0823	0.6793	2	Qualified
S9	0.0203	0.0690	0.0243	0.0139	0.0959	0.0317	0.2486	26	Not Qualified
S10	0.0405	0.0455	0.0406	0.0173	0.0779	0.0420	0.3505	22	Not Qualified
S11	0.0203	0.0710	0.0162	0.0069	0.1018	0.0276	0.2136	29	Not Qualified
S12	0.0810	0.0710	0.0324	0.0104	0.0534	0.0710	0.5708	7	Qualified
S13	0.1013	0.0613	0.0568	0.0035	0.0516	0.0959	0.6502	4	Qualified
S14	0.1013	0.0665	0.0406	0.0000	0.0563	0.0898	0.6146	6	Qualified
S15	0.0203	0.0733	0.0487	0.0278	0.0854	0.0565	0.3981	16	Not Qualified

S16	0.0203	0.0482	0.0324	0.0035	0.1015	0.0248	0.1960	30	Not Qualified
S17	0.0608	0.0628	0.0162	0.0208	0.0668	0.0494	0.4252	13	Not Qualified
S18	0.0203	0.0733	0.0487	0.0278	0.0854	0.0565	0.3981	16	Not Qualified
S19	0.0203	0.0740	0.0324	0.0382	0.0859	0.0535	0.3838	19	Not Qualified
S20	0.0810	0.0600	0.0162	0.0208	0.0574	0.0663	0.5360	8	Qualified
S21	0.0810	0.0716	0.0162	0.0520	0.0452	0.0845	0.6517	3	Qualified
S22	0.0810	0.0577	0.0243	0.0104	0.0597	0.0649	0.5209	9	Qualified
S23	0.0608	0.0699	0.0487	0.0104	0.0598	0.0632	0.5138	10	Qualified
S24	0.1013	0.0701	0.0243	0.0173	0.0485	0.0879	0.6444	5	Qualified
S25	0.0405	0.0660	0.0406	0.0139	0.0747	0.0456	0.3789	20	Not Qualified
S26	0.0405	0.0693	0.0324	0.0104	0.0784	0.0410	0.3432	23	Not Qualified
S27	0.0608	0.0656	0.0162	0.0000	0.0787	0.0459	0.3685	21	Not Qualified
S28	0.0608	0.0720	0.0243	0.0173	0.0631	0.0539	0.4606	12	Not Qualified
S29	0.1013	0.0656	0.0487	0.0139	0.0412	0.0938	0.6948	1	Qualified
S30	0.0203	0.0662	0.0487	0.0000	0.0977	0.0455	0.3179	24	Not Qualified