Data-Driven Decision Analysis on the Selection of Course Programmes with AHP-TOPSIS Model

Lam Weng Hoe[#*1], Lam Weng Siew[#*2], Liew Kah Fai[#*3], Wong Soong Cheong[#4]

[#] Department of Physical and Mathematical Science, Faculty of Science, Universiti Tunku Abdul Rahman, Kampar Campus, Jalan Universiti, Bandar Barat, 31900 Kampar, Perak, Malaysia

[*] Centre for Mathematical Sciences, Universiti Tunku Abdul Rahman, Kampar Campus, Jalan Universiti, Bandar Barat, 31900 Kampar, Perak, Malaysia

[1]whlam@utar.edu.my

[2]lamws@utar.edu.my

[3]liewkf@utar.edu.my

[4]soongcheong@1utar.my

***Abstract*— The course selection has become a favorite issue among the students who pursue their tertiary study in university nowadays. This is because there are a lot of course programmes offered in this knowledge-based education system. Besides that, other factors such as the financial problem, motivation, self-interest, moral support from friends and family are important criteria in the selection of course programmes. The objective of this study is to propose a data-driven conceptual framework to determine the student preference in the selection of course programmes with Analytic Hierarchy Process – Technique for Order of Preference by Similarity to Ideal Solution (AHP-TOPSIS) model. Moreover, this study also aims to determine the priority of the decision criteria that influence the selection of course programmes among the students. In this study, the target respondents are the science stream students from Universiti Tunku Abdul Rahman, Malaysia who provide the inputs as data-driven decision analysis on the selection of course programmes. The results of this study show that medical science is the most preferred course programmes among the students followed by engineering, science and lastly information system. On the other hand, career prospect has been identified as the most concerned decision criterion by the student in the selection of course programmes. This study is significant because it helps to determine the most preferred course programme as well as the most influential criteria in the selection of course programmes among the students with the proposed conceptual framework based on AHP-TOPSIS model.**

***Keywords*—*Course Programmes, Multi-Criteria Decision Making, Conceptual Framework, Priority*

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1. Introduction

Nowadays, the course selection has become a favorite issue among the undergraduates who pursue their tertiary study in university. The evaluation of course programme has been a research topic of continuous interest such as engineering, information system, science and medical science [1]. Career prospect, personal interest, study fees, recommendation from others and duration of study are the main decision criteria for the selection of the course programme [2-7]. Career prospect is the chance of getting a job after completion of the particular course [8]. Personal interest is the criteria which help to measure the students' interest in a particular area or course [8]. Study fees are the tuition fee for the whole course programme. Recommendation from others is the suggestion given by other people to the students in pursuing their studies. Duration of study is the number of years required for completion of the particular course [8]. Due to the importance of these five decision criteria based on the past studies, therefore the decision criteria such as career prospect, personal interest, study fees, recommendation from others and duration of study should be considered by the students before they choose the course programmes.

Selection of course programmes is a multi-criteria decision making problem. Analytic Hierarchy Process – Technique for Order of Preference by Similarity to Ideal Solution (AHP-TOPSIS) is a decision making model which helps to identify the best alternatives based on multiple criteria [9-15]. AHP model can be used to determine the priorities or weights of the decision criteria and the TOPSIS model can be applied to rank the course programmes based on the idea of choosing the alternative that has the farthest distance from the negative ideal solution (NIS) and the shortest distance to the positive ideal solution (PIS). Moreover, AHP model is able to validate the proposed conceptual framework by checking the consistency of the pairwise comparison matrix of the decision criteria. This study illustrates the robustness and effectiveness of the proposed conceptual framework based on AHP-TOPSIS model. AHP-TOPSIS model has been widely applied in various fields such as airports industry [16], cotton fibre industry [17], production companies [18], customer-oriented product design process [19], textile industry [20] and mobile network operators [21]. The objective of this paper is to propose a conceptual framework to determine the student preference in the selection of course programmes among engineering, information system, science and medical science with AHP-TOPSIS model. Besides that, this paper also aims to identify the priority of the decision criteria that influence the selection of course programmes among the students from Universiti Tunku Abdul Rahman (UTAR) in Malaysia. The rest of the paper is organized as follows. The following section discusses about the data and methodology used in this study. The empirical results of this study are presented in section 3. Section 4 concludes the paper.

2. Data and Methodology

2.1 Data-Driven Conceptual Framework

The proposed data-driven conceptual framework consists of three stages to determine the student preference in the selection of course programmes with AHP-TOPSIS model.

Stage 1: Identify the decision criteria and decision alternatives for the selection of course programmes. Table 1 presents the proposed hierarchy structure in this study.

Table 1. Proposed Hierarchy Structure

Level	
Level 1 (Main objective)	Selection of course programme
Level 2 (Decision criteria)	Personal interest (PI) Study fees (SF) Career prospect (CP) Recommendation from others (RO) Duration of study (DS)
Level 3 (Decision alternative)	Engineering Information system Science Medical science

Table 1 shows the three levels of hierarchy in this study, which consists of the main objective, decision criteria and decision alternatives for the selection of course programmes. As shown in Table 1, the course programmes such as engineering, information system, science and medical science are the decision alternatives in this study. Moreover, the decision criteria consist of career prospect, personal interest, study fees, recommendation from others and duration of study.

Stage 2: Determine the weights or priorities of decision criteria with AHP.

Stage 3: Rank the decision alternatives with TOPSIS and determine the best alternative.

In this study, the target respondents are the 50 science stream students from the foundation studies, Universiti Tunku Abdul Rahman (UTAR), Malaysia in year 2017. These students are the decision makers who will pursue bachelor degree in the field of engineering, information system, science or medical science. The students provide the inputs as data-driven decision analysis on the selection of course programmes in this study.

2.2 Analytic Hierarchy Process (AHP)

AHP is a multi-criteria decision making model which helps the decision makers to prioritize the decision criteria [22-25]. AHP model consists of two steps as shown below [26].

Step 1: Construct the pairwise comparison matrix. Each decision criterion is compared in pairwise in order to obtain its relative importance to the problem. The ratio scale for pairwise comparison is shown in Table 2 [22-25].

Table 2. Ratio Scale Used for Pairwise Comparison

Scale	**Definition**
1	A and B are of equal importance
3	A has a moderate importance than B
5	A has a strong importance than B
7	A has a very strong importance than B
9	A has an extreme importance than B
2, 4, 6, 8	Intermediate importance

The pairwise comparison matrix M for n decision criteria is as shown below.

$$M=\begin{bmatrix} 1 & c_{12} & c_{13} & \cdots & c_{1n} \\ 1/c_{12} & 1 & c_{23} & \cdots & c_{2n} \\ 1/c_{13} & 1/c_{23} & 1 & \cdots & c_{3n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ 1/c_{1n} & 1/c_{2n} & 1/c_{3n} & \cdots & 1 \end{bmatrix} \quad (1)$$

c_{ij} represents the degree of preference of element i to element j.

Step 2: Compute the weights of decision criteria by using the normalization method. New normalized matrices are formed by dividing each element in the column by column's sum. Next, determine the priority or weights of the decision criteria by taking the average of each row. Lastly, check the consistency of the decision criteria pairwise comparison matrix.

$$w_i = \frac{1}{n}\sum_{j=1}^{n} c_{ij}\ ,\ i = 1,2,3,\ldots,n \quad (2)$$

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

TOPSIS model aims to determine the best alternative selection based on the idea of choosing the alternative that has the farthest distance from the NIS and the shortest distance to the PIS [27]. TOPSIS model comprises seven steps as presented below [21, 27].

Step 1: Establish the decision matrix ($(x_{ij})_{m\times n}$):

A $m \times n$ decision matrix is formed. m refers to the alternatives and n refers to the criteria.

Step 2: Calculate a normalized decision matrix:

Normalization method is used to form a normalized decision matrix $R=(r_{ij})_{m\times n}$.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, i = 1,2,\ldots, m,\ j = 1,2,\ldots, n \quad (3)$$

Step 3: Construct the weighted normalized decision matrix (T):

The weighted normalized decision matrix is calculated as follow.

$$\mathbf{T} = (t_{ij})_{m\times n} = (w_j r_{ij})_{m\times n}, i = 1,2,\ldots,m \quad (4)$$

Step 4: Identify the positive ideal solution (PIS) and negative ideal solution (NIS):

$$\text{PIS} = \{\langle \min(t_{ij} \mid i = 1,2,\ldots,m) \mid j \in J_- \rangle, \langle \max(t_{ij} \mid i = 1,2,\ldots,m) \mid j \in J_+ \rangle\} \equiv \{t_{bj} \mid j = 1,2,\ldots,n\}, \quad (5)$$

$$\text{NIS} = \{\langle \max(t_{ij} \mid i = 1,2,\ldots,m) \mid j \in J_- \rangle, \langle \min(t_{ij} \mid i = 1,2,\ldots,m) \mid j \in J_+ \rangle\} \equiv \{t_{wj} \mid j = 1,2,\ldots,n\}, \quad (6)$$

Where J_+ is associated with the positive impact criteria and J_- is associated with the negative impact criteria.

Step 5: Calculate the separation distance of each alternative from the PIS (d_{ib}) and NIS (d_{iw}):

$$d_{ib} = \sqrt{\sum_{j=1}^{n} (t_{ij} - t_{bj})^2}, i = 1,2,\ldots, m \quad (7)$$

$$d_{iw} = \sqrt{\sum_{j=1}^{n} (t_{ij} - t_{wj})^2}, i = 1,2,\ldots, m \quad (8)$$

Step 6: Measure the relative distances from the ideal solution:

Calculate the relative closeness to the ideal solution (s_{iw}).

$$s_{iw} = \frac{d_{iw}}{d_{ib} + d_{iw}}, 0 \le s_{iw} \le 1, i = 1,2,\ldots, m \quad (9)$$

Step 7:

Rank all the decision alternatives in descending order according to the s_{iw} and select the best decision alternative with the largest s_{iw}. The decision alternative that has the closest distance to the PIS and farthest from the NIS is the best alternative.

3. Empirical Results

Figure 1 presents the overall weights in the selection of course programmes among the students based on the proposed data-driven conceptual framework with AHP-TOPSIS model.

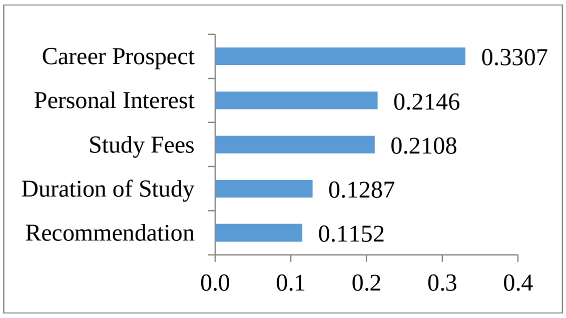

Figure 1. Weights of decision criteria in the selection of course programmes

As presented in Figure 1, the weights of decision criteria in the selection of course programmes is career prospect (0.3307) followed by personal interest (0.2146), study fees (0.2108), duration of study (0.1287) and finally recommendation from others (0.1152). Based on the results, career prospect is identified as the most important criterion among the students in the selection of course programmes. This indicates that the students are very concern on their future career prospect. On the other hand, the criteria such as duration of study and recommendation from others are less likely to be taken into consideration in the selection of course programmes among the students. In this study, the overall consistency ratio is 0.0031 which is well below 0.1000. This indicates that the decision criteria pairwise comparison matrix does not exhibit any inconsistencies. Hence, the results for this study using AHP model are reliable and acceptable.

Figure 2 to Figure 6 show the preference of course programmes based on each decision criterion.

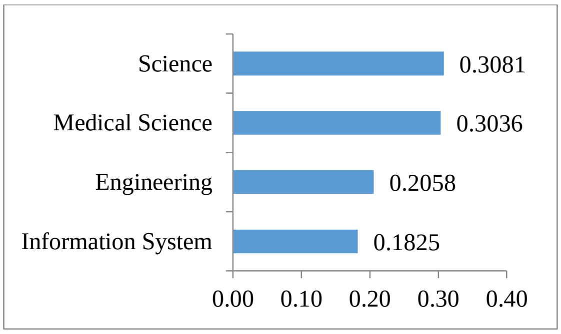

Figure 2. Preference of course programmes based on personal interest

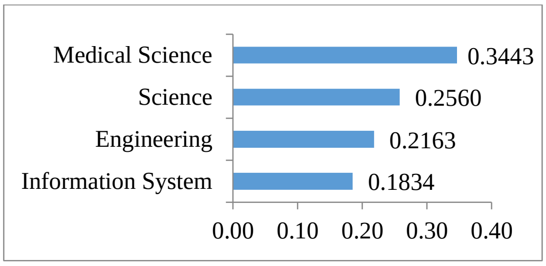

Figure 3. Preference of course programmes based on study fees

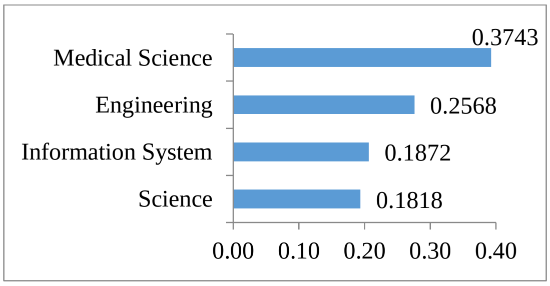

Figure 4. Preference of course programmes based on career prospect

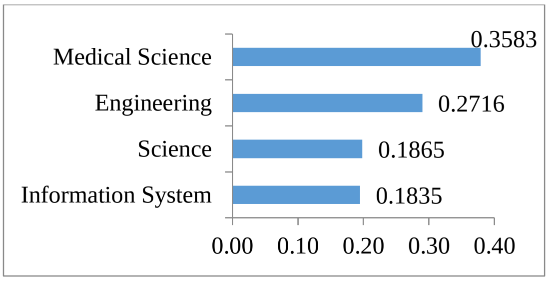

Figure 5. Preference of course programmes based on recommendation from others

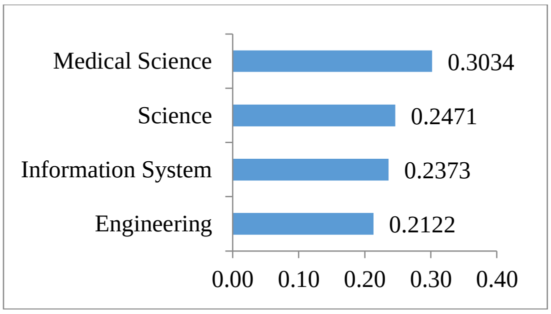

Figure 6. Preference of course programmes based on duration of study

From Figure 2 to Figure 6, medical science achieves the first ranking in most of the decision criteria such as study fees (0.3443), career prospect (0.3743), recommendation from others (0.3583) and duration of study (0.3034). In terms of personal interest, medical science is ranked at the second place (0.3036), whereas the first ranking belongs to the science programme (0.3081). Information system obtains the third or last ranking with respect to all the decision criteria. Engineering programme achieves the second ranking for career prospect (0.2568) and recommendation from others (0.2716) whereas the third ranking for personal interest (0.2058) and study fees (0.2163).

Figure 7 shows the positive ideal solution and negative ideal solution for each decision criterion.

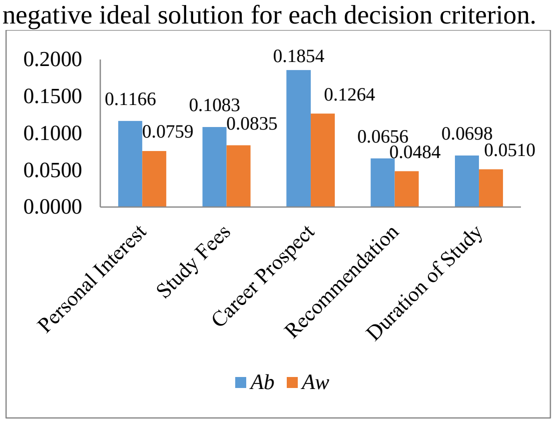

Figure 7. The positive ideal solution and negative ideal solution for each decision criterion

As shown in Figure 7, the positive ideal solution that determined by the AHP-TOPSIS model for personal interest, study fees, career prospect, recommendation from others and duration of study are 0.1166, 0.1083, 0.1854, 0.0656 and 0.0698 respectively. On the other hand, the negative ideal solution for personal interest, study fees, career prospect, recommendation from others and duration of study are 0.0759, 0.0835, 0.1264, 0.0484 and 0.0510 respectively.

Figure 8 presents the distance of all decision alternatives from the positive ideal solution (d_{ib}).

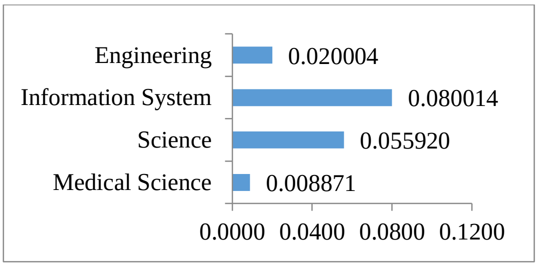

Figure 8. The distance of all course programmes from the positive ideal solution (d_{ib})

Figure 9 presents the distance of all decision alternatives from the negative ideal solution (d_{iw}).

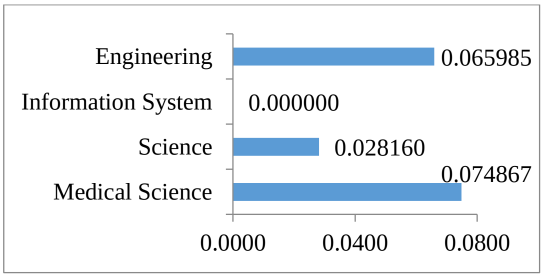

Figure 9. The distance of all course programmes from the negative ideal solution (d_{iw})

The distance of all decision alternatives from the negative ideal solution (d_{iw}) for engineering, information system, science and medical science are 0.065985, 0.000000, 0.028160 and 0.074867 respectively. On the other hand, the distance of all decision alternatives from the positive ideal solution (d_{ib}) for engineering, information system, science and medical science are 0.020004, 0.080014, 0.055920 and 0.008871 respectively.

Table 3 presents the relative closeness coefficient to the ideal solution and the ranking of the course programmes.

Table 3. Ranking of Course Programmes

Course programme	**Relative closeness to the ideal solution, s_{iw}**	**Rank, T**
Medical science	0.8941	1
Engineering	0.7674	2
Science	0.3349	3
Information system	0.0000	4

As presented in Table 3, the relative closeness coefficient to the ideal solution, s_{iw} for medical science is 0.8941, which is the highest relative to other course programmes. Therefore, medical science is the most preferred course programme among the students with respect to all decision criteria. The preference of the course programmes is followed by engineering (0.7674), science (0.3349) and lastly information system (0.0000). As a result, the information system is the least favor course programme among the students from UTAR. According to the study by Altin and Rantsus [28], the researchers found that the information system course programme was not the right choice for the students by personal point of view and also the students are not be sure about an IT-related career. Therefore, the information system course programme has not become the ideal course programme for the science stream students from foundation studies.

4. Conclusion

This paper aims to propose a data-driven conceptual framework to determine the student preference in the selection of course programmes among engineering, information system, science and medical science with AHP-TOPSIS model. The results of this study show that career prospect is ranked as the most influential criterion in the selection of the course programmes followed by personal interest, study fees, duration of study and lastly recommendation from others. Medical science has become the top choice among the science steam students in the selection of course programmes followed by engineering, science and finally information system. The significance of this study is to identify the most preferred course programme and also the most influential criteria in the selection of course programmes among the science stream students with the proposed conceptual framework based on AHP-TOPSIS model. In future research, enlarging the scope of respondents to the students that are from different universities can be considered in order to determine the preferences of other students toward the selection of the course programmes.

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