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# Analysing Influential Factors in University Selection Using Fuzzy TOPSIS

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## HIGHLIGHTS

- University selection has an impact on a person's life especially high school leavers to determine their future.
- The influence of family, the influence of friends, the university's environment, the university's image, suitability with personality and interest, and education cost are the important factors in university selection.
- Fuzzy TOPSIS was used to rank the factors influencing university selection among students.
- The closeness coefficient with the highest value shows the most influencing factors.

## ABSTRACT

*Students must carefully choose their university because it will affect their motivation for studying, dedication, and engagement with the university. Normally, students will consider some factors that influence their choice of the university. Therefore, this study aims to determine the most important factor that influences students' choice of university. The study also analyses the preferable university either IPTA or IPTS. Besides, the study is conducted to rank the six variables: the influence of family, the influence of friends, the university's image, the university's environment, suitability with personality and interest, and financial support. The data was collected by distributing questionnaires to 30 experts which are teachers and counsellors. They are required to evaluate the issues in this study using linguistic variables ranging from "unaffected" to "very affected". The data was analysed using Fuzzy TOPSIS. The finding shows that the most influential factor in deciding the university selection is the suitability with personality and interest with a closeness coefficient of 0.4869. The influence of friends is the least important in university selection with a closeness coefficient of 0.4713. This study's findings might benefit communities such as students, parents, and teachers. Universities may also benefit from it because they need to attract more students to expand their market.*

***Keywords:*** *Fuzzy TOPSIS, rank, university selection*

## INTRODUCTION

Higher education is the third level of education after students leave school. It is an optional and final stage of formal learning that occurs after the students finish secondary education. Studying at a higher education institution is important to students, as supported by Hieu et al. (2020) who claimed that in this modern era, parents, educational administrators or policymakers, and other stakeholders believe that higher education and adequate preparation are needed for all human beings to secure a bright future. There are two categories of universities; public universities (IPTA) and private universities (IPTS). Although they offer almost the same package for pre-university, matriculation, or diploma programs, there are significant differences in terms of quality and reputation among these institutions.

The university selection not only affects the students' future careers, but also their study motivation, commitment, and interaction with the university. There are many reasons why candidates choose a particular university to pursue their studies. Six common factors can influence students in choosing a university, which are the influence of family, the influence of friends, the university's environment, the university's image, suitability with personality and interest, and education cost. Following this, this study aims to determine the main factor that affects university selection.

### Influence of Family

Parents and relatives can influence students' choices in terms of past experiences and looking at the university from different perspectives, including location, pastoral support, and the overall credibility of the institution. Parents always want their children to have a successful future, and their children must be able to earn a good income and maintain a steady job. To do so, the family frequently believes that their children must obtain a degree from a prestigious college or university. This causes families to push their children to get into a good school, which has an impact on their children's post-secondary education and career opportunities (Afzal Humayon et al., 2018). Besides that, some students are influenced by professions that are in their parents' favour. It makes them go to whatever university their parents want them to go to and take whatever courses their parents want them to take so that they can get the profession that their parents favour.

### Influence of Friends

Friends also influence students in making their university selections. This is due to the time they spend with each other when growing up. Sometimes, the choice is to choose the same university as their friends. Students seek friends who are similar to them in terms of academic achievement and school involvement. Their disruptive behaviours, academic achievement, and school enrolment influence students as well (Wang et al., 2018). Some students think that if they enter the same university as their best friend, they can succeed since they used to study together. This shows that friends also play an important role in deciding which university to choose so they can study together while pursuing tertiary education.

### Suitability with Personality and Interest

Personality may also determine the future career that a student may choose, influencing whether they are happy with the job. The students should pursue their studies based on their personality and interests to encourage them and make them enjoy their studies by studying what they love. Students' passion for certain courses is likely to result in improved exam results and a career choice in the same field. Regarding the factors influencing the professional path chosen by students, liking the subject is the most important aspect. A person's preference for certain work, as well as the compatibility of his/her personality with the profession he chooses, is an important element in determining his/her career path (Afaq Ahmed et al., 2017).

## University's Image

A university's image relates to its reputation of the university. The higher the rank of a university, the better the reputation of the university. Rankings play a big role in shaping the opinions of current and potential students, parents, employers, and the government about the quality of tertiary education institutions. Parents and students often prefer higher-ranking universities as the best choice. This is supported by Jabjaimoh et al. (2019), who said that the world university rankings are highly competitive among educational institutions since they create an opportunity to attract quality resources such as staff and students. University ranking can also be used as an early shortlisting tool. University rankings can reduce the list and make the decision-making process easier for students to search for the top university for a certain course. Students can also use rankings as a fast reputation check when comparing lesser-known universities to determine where they rank.

## University's Environment

The university environment is one of the aspects that affect students' reputation because a good environment can help students study easily. Once the facilities are complete and are of good quality, students can fully engage in the learning process (Muhsin et al., 2020). Having good facilities such as lecture room facilities, library facilities, accommodation facilities, employment facilities, and entertainment facilities can give satisfaction to the students when studying. It is necessary for universities to maintain the most up-to-date services and to ensure that the facilities and services can effectively satisfy the needs of students, who are the university's primary clients (Muttaqien, 2021). The location of the university is also important. Students prefer to enter a university nearer to the city instead of a rural area or the suburbs because the city provides more facilities.

## Education Cost

Money is an important weapon in the modern world economy. Everything requires money, including education. Education is not free and can also affect students' choice of university depending on the cost of education. Not everyone can afford to pay university fees, whether public or private. Some students need to apply for financial aid such as scholarships or study loans to further their tertiary education, and some stop studying and start working. Thus, to attract and promote their academic programmes, administrators, marketers, and policymakers should constantly review their education prices. If a higher education institution focuses on lowering the cost of education, this will help attract more students to apply. Students are cost-conscious and prefer to apply to universities that offer high-quality courses at reasonable prices (Bibi Noraini et al., 2017). Therefore, many students choose public universities instead of private universities because they provide cheaper education costs.

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

Hwang and Yoon introduced TOPSIS, which is the most well-known technique for solving MCDM problems. The chosen option should have the minimum distance to the Fuzzy Positive Ideal Solution (FPIS). It is a solution that reduces the cost criterion while increasing the benefit criterion and is the furthest away from the Fuzzy Negative Ideal Solution (FNIS) (Nădăban et al., 2016).

Fuzzy TOPSIS has been used in the past to analyse data in many different fields. For example, a study conducted by Jusoh @ Hussain et al. (2021) investigated the most important factor that influenced flood frequency in Kedah. The study's outcome was obtained after computing the closeness coefficient. As the initial ranking, the highest proximity coefficient value closest to FPIS is chosen. After using Fuzzy TOPSIS, the study concluded that rainfall was the most important factor that caused flooding in Kedah. The closeness coefficient of rainfall calculated was 0.318, the highest value among the other variables. This shows that the study's objective of ranking alternative flood factors was accomplished.

Apart from that, a study related to the application of Fuzzy conducted by Muhammat Pazil et al. (2018) sought to identify the major factor influencing Malaysians' choice of university. The factors used in the study are affiliation, cost of education, course offered, and reputation. According to the closeness coefficient values of the four factors, affiliation had the highest coefficient value of 0.75 and was placed first. As a result, the institution's affiliation was regarded as the most important factor to consider while selecting a university.

# METHODOLOGY

## Data Collection

The data were collected by distributing the questionnaires using the platform Google form to 30 experts which are teachers and counsellors. The questionnaires ask respondents to rank alternatives for the criterion using the study's selected linguistics scales. The method used in this study is the Fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

## Steps in Fuzzy TOPSIS

There are six alternatives and two criteria used in this study. The alternatives are the influence of family, influence of friends, the university's environment, university image, suitability with personality and interest, and education cost. Meanwhile, the criteria are the public university (IPTA) and the private university (IPTS).

### *Step 1: Assigning a score to criteria and alternatives*

Assign a score to each of the criteria and alternatives. This study will assume to have a $K$ member decision-making group. The Fuzzy rating of the $k^{th}$ decision-maker about alternative $A_i$ with respect to criterion $C_j$ is denoted as $\widetilde{x_{ij}^k} = (a_{ij}^k, b_{ij}^k, c_{ij}^k)$, while the weight of the criterion $C_j$ is denoted as $\widetilde{w_j^k} = (w_{j1}^k, w_{j2}^k, w_{j3}^k)$. The respondent information is represented as ordered Fuzzy numbers. Some conversion scales have been used to convert language concepts into fuzzy numbers. Based on Sodhi and Tadinada. (2012), the criteria and options are rated on a scale of 1 to 9. Table 1 shows a summary of the Fuzzy ratings for the linguistic variable:

**Table 1:** Linguistic variables and Fuzzy numbers for rating influential factors

| **Fuzzy number** | **Alternative assessment** |
|---|---|
| (1,1,3) | Unaffected (UA) |
| (1,3,5) | Less Affected (LA) |
| (3,5,7) | Neutral (N) |
| (5,7,9) | Affected (AF) |
| (7,9,9) | Very Affected (VA) |

***Step 2: Compute the aggregate fuzzy ratings for alternative and the aggregate Fuzzy weight for criteria***

The aggregate Fuzzy rating $\widetilde{x_{IJ}} = (a_{ij}, b_{ij}, c_{ij})$ of $i^{th}$ alternative with respect to $j^{th}$ criterion is given by:

$$a_{ij} = \min_k\{a_{ij}^k\} \; , b_{ij} = \frac{1}{k}\sum_{k=1}^{k} b_{ij}^k \; , c_{ij} = \max_k\{c_{ij}^k\} \tag{1}$$

The aggregate Fuzzy weight $\widetilde{w_J} = (w_{j1}, w_{j2}, w_{j3})$ for the criterion $C_j$ was calculated by:

$$w_{j1} = \min_k\{w_{j1}^k\} \; , w_{j2} = \frac{1}{k}\sum_{k=1}^{k} w_{j2}^k \; , w_{j3} = \max_k\{w_{j3}^k\} \tag{2}$$

***Step 3: Compute the normalized Fuzzy decision matrix***

The normalized Fuzzy decision matrix is $\tilde{R} = [\widetilde{r_{IJ}}]$, where

$$\widetilde{r_{IJ}} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right), \text{ and } c_j^* = \max_i\{c_{ij}\} \text{ (benefit criteria)} \tag{3}$$

$$\widetilde{r_{IJ}} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right), \text{ and } a_j^- = \min_i\{a_{ij}\} \text{ (cost criteria)} \tag{4}$$

***Step 4: Compute the weighted normalized Fuzzy decision matrix***

The weighted normalized Fuzzy decision matrix is

$$\tilde{V} = (\widetilde{v_{IJ}}), \text{ where } \widetilde{v_{IJ}} = \widetilde{r_{IJ}} \times w_j \tag{5}$$

***Step 5: Compute the Fuzzy Positive Ideal Solution (FPIS) and Fuzzy Negative Ideal Solution (FNIS)***

The following shows the calculation for FPIS and FNIS:

$$A^+ = (\widetilde{v_1^+}, \widetilde{v_2^+}, \dots, \widetilde{v_n^+}), \text{ where } \widetilde{v_J^+}, = \max_i\{v_{ij3}\} \tag{6}$$

$$A^- = (\widetilde{v_1^-}, \widetilde{v_2^-}, \dots, \widetilde{v_n^-}), \text{ where } \widetilde{v_J^-}, = \min_i\{v_{ij1}\} \tag{7}$$

where $A^+$ is for FPIS and $representsA^-$ represent FNIS.

***Step 6: Compute the distance from each alternative to the FPIS and FNIS***

Alternative ratings and weights of criteria were evaluated using linguistic values, represented by a Triangular Fuzzy Number (TFN). The distance of criteria of each alternative from FPIS and FNIS was computed as follows:

$$the\ the\ the\ d(\tilde{x}, \tilde{y}) := \sqrt{\frac{1}{3}[(a_1 - a_2)^2 + (b_1 - b_2)^2 + (c_1 - c_2)^2]}. \tag{8}$$

Let

$$d_i^+ = \sum_{j-1}^{n} d(\widetilde{v_{IJ}}, \widetilde{v_J^*}), \quad d_i^- = \sum_{j-1}^{n} d(\widetilde{v_{IJ}}, \widetilde{v_J^-}), \tag{9}$$

be the distance from each alternative $A_i$ to the FPIS and the FNIS, respectively.

***Step 7: Compute the closeness coefficient***

Compute the closeness coefficient $CC_i$ for each alternative. For each alternative $A_i$, calculate the closeness coefficient $CC_i$ as follows:

$$CC_i = \frac{d_i^-}{d_i^- + d_i^+} \tag{10}$$

***Step 8: Rank the alternatives***

The alternative with the highest closeness coefficient represents the highest affecting factor.

## FINDINGS AND DISCUSSIONS

The alternatives (influence of family (A1), influence of friends (A2), university's environment (A3), university's image (A4), suitability with personality and interest (A5), and education cost(A6)) and criteria (public university (IPTA) and the private university (IPTS)) for 30 decision-makers were rated by their importance or significance based on the linguistic variables listed in Table 1. All of the responses were gathered and analysed. Table 2 shows the criteria weightage considered by one of the decision-makers (DM1). Table 3 also shows the results of the analysis of alternative ratings by one of the decision-makers.

**Table 2:** Criteria weightage

| Criteria | DMI |
|---|---|
| IPTA | N |
| IPTS | VA |

**Table 3:** Alternative weightage

| | Alternative | | | | | |
|---|---|---|---|---|---|---|
| **Criteria** | A1 | A2 | A3 | A4 | A5 | A6 |
| **IPTA** | N | AF | N | AF | AF | VA |
| **IPTS** | VA | LA | VA | VA | VA | N |

Then, the fuzzy number based on Table 1, for both criteria weightage and alternative rating is applied. Table 4 shows the fuzzy number for criteria weightage, and Table 5 shows the fuzzy number for alternative rating.

**Table 4:** Fuzzy number for criteria weightage

| Criteria | DM1 |
|---|---|
| IPTA | (3.000, 5.000, 7.000) |
| IPTS | (7.000, 9.000, 9.000) |

**Table 5:** Fuzzy number for alternative weightage

| | Alternative | | | | | |
|---|---|---|---|---|---|---|
| **Criteria** | **A1** | **A2** | **A3** | **A4** | **A5** | **A6** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **IPTA** | (3.000,5.000,7.000) | (5.000,7.000,9.000) | (3.000,5.000,7.000) | (5.000,7.000,9.000) | (5.000,7.000,9.000) | (7.000,9.000,9.000) |
| **IPTS** | (7.000, 9.000, 9.000) | (1.000, 3.000, 5.000) | (7.000, 9.000, 9.000) | (7.000, 9.000, 9.000) | (7.000, 9.000, 9.000) | (3.000, 5.000, 7.000) |

The combined fuzzy weights for the criterion and alternatives for 30 respondents were calculated using the outputs. equation (1) was used to get the combined fuzzy weights for the alternatives, while equation (2) was used to get the combined fuzzy weight for the criteria. Table 6 and Table 7 show the aggregated fuzzy weights of criteria, and ratings of alternatives were computed and shown.

**Table 6:** The aggregate fuzzy decision matrix for criteria weightage

| Criteria | Aggregated Weightage |
|---|---|
| IPTA | (3.0000, 7.2667, 9.0000) |
| IPTS | (1.0000, 6.0667, 9.0000) |

**Table 7:** The aggregate fuzzy decision matrix for alternative

| Criteria | A1 | A2 | A3 | A4 | A5 | A6 |
|---|---|---|---|---|---|---|
| **IPTA** | (1.000,7.467,9.000) | (1.000, 6.400, 9.000) | (3.000, 7.667, 9.000) | (3.000, 7.667, 9.000) | (1.000, 6.933, 9.0000) | (3.000, 7.400, 9.000) |
| **IPTS** | (1.000,5.133,9.000) | (1.000, 4.467, 9.000) | (1.000, 6.267, 9.000) | (1.000, 6.533, 9.000) | (1.000, 6.133, 9.000) | (1.000, 6.467, 9.000) |

From Table 6, IPTA was classified as the benefit criteria and IPTS as the cost criteria. The decision was made based on the weight level of the criteria listed in Table 1. If the weight level is high, it will be determined as a benefit criterion. Meanwhile, if the level of weight is low, it will be determined as a cost criterion. Equation (3) was used to compute the normalized fuzzy decision matrix for benefit criteria, and equation (4) was used for cost criteria. Table 8 shows the normalized aggregate fuzzy decision matrix for all the alternatives.

**Table 8:** Normalized aggregated fuzzy decision matrix for alternative

| Criteria | A1 | A2 | A3 | A4 | A5 | A6 |
|---|---|---|---|---|---|---|
| **IPTA** | (0.111,0.830,1.000) | (0.111,0.711,1.000) | (0.333,0.852,1.000) | (0.333,0.852,1.000) | (0.111,0.770,1.000) | (0.333,0.822,1.000) |
| **IPTS** | (0.111,0.195,1.000) | (0.111,0.224,1.000) | (0.111, 0.160,1.000) | (0.111, 0.153,1.000) | (0.111, 0.163, 1.000) | (0.111, 0.155,1.000) |

Table 9 shows the weighted normalized fuzzy decision matrix calculated by using equation (5).

**Table 9:** Weight normalized fuzzy decision matrix

| Criteria | A1 | A2 | A3 | A4 | A5 | A6 |
|---|---|---|---|---|---|---|
| **IPTA** | (0.333, 6.028, 9.000) | (0.333, 5.167, 9.000) | (1.000, 6.191, 9.000) | (1.000, 6.190, 9.000) | (0.333, 5.598, 9.000) | (1.000, 5.975, 9.000) |
| **IPTS** | (0.111, 1.182, 9.000) | (0.111, 1.358, 9.000) | (0.111, 0.968, 9.000) | (0.111, 0.929, 9.000) | (0.111, 0.989, 9.000) | (0.111, 0.931, 9.000) |

The FPIS and FNIS were calculated using equations (6) and (7) as shown in Table 10.

**Table 10:** FPIS and FNIS for each criterion

| Criteria | A+ | A- |
|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| **IPTA** | 9.0000 | 9.0000 | 9.0000 | 0.3333 | 0.3333 | 0.3333 |
| **IPTS** | 9.0000 | 9.0000 | 9.0000 | 0.1111 | 0.1111 | 0.1111 |

The distance of alternatives from FPIS and FNIS was determined by using equation (8) and equation (9). Tables 11 and Table 12 imply the result of the distance of alternatives from FPIS and FNIS.

**Table 11:** Distance of alternatives from FPIS

| Criteria | FPIS(A1) | FPIS(A2) | FPIS(A3) | FPIS(A4) | FPIS(A5) | FPIS(A6) |
|---|---|---|---|---|---|---|
| **IPTA** | 5.2896 | 5.4711 | 4.8954 | 4.8954 | 5.3754 | 4.9380 |
| **IPTS** | 6.8346 | 6.7678 | 6.9167 | 6.9321 | 6.9086 | 6.9283 |
| $d_i^+$ | 12.1242 | 12.2389 | 11.8122 | 11.8275 | 12.2840 | 11.8664 |

**Table 12:** Distance of alternatives from FNIS

| Criteria | FNIS(A1) | FNIS(A2) | FNIS(A3) | FNIS(A4) | FNIS(A5) | FNIS(A6) |
|---|---|---|---|---|---|---|
| **IPTA** | 5.9874 | 5.7294 | 6.0514 | 6.0514 | 5.8546 | 5.9828 |
| **IPTS** | 5.1691 | 5.1823 | 5.1558 | 5.1537 | 5.1570 | 5.1542 |
| $d_i^-$ | 11.1565 | 10.9117 | 11.2072 | 11.2050 | 11.0116 | 11.1370 |

The closeness coefficient, $CCxx$ for each alternative was calculated according to equation (10), and the results are shown in Table 13.

**Table 13:** Computation $d_i^+, d_i^-$ and $CC_x$

| Alternative | $d_i^+$ | $d_i^-$ | $CC_x$ |
|---|---|---|---|
| **A1** | 12.1242 | 11.1565 | 0.4792 |
| **A2** | 12.2389 | 10.9117 | 0.4713 |
| **A3** | 11.8122 | 11.2072 | 0.4869 |
| **A4** | 11.8275 | 11.2050 | 0.4865 |
| **A5** | 12.2840 | 11.0116 | 0.4727 |
| **A6** | 11.8664 | 11.1370 | 0.4841 |

**Table 14:** Ranking of each alternative

| Rank | $CC_x$ | Alternative |
|---|---|---|
| **1** | 0.4869 | Personality and interest (A3) |
| **2** | 0.4865 | University's image (A4) |
| **3** | 0.4841 | Education cost (A6) |
| **4** | 0.4792 | Influence of family (A1) |
| **5** | 0.4727 | University's environment (A5) |
| **6** | 0.4713 | Influence of friends (A2) |

Table 14 shows that suitability with personality and interest (A3) is the most important factor that affects university selection among high school leavers, with the highest closeness coefficient of 0.4869. Students prefer to pursue their studies based on what they love and want an excellent result for a better future. Next, it is followed by (A4), the university's image with 0.4865 closeness coefficient. Next is the education cost (A6) with 0.4841 closeness coefficient, followed by the influence of family (A1) and university's environment (A5) with 0.4792 and 0.4727 closeness coefficient. Finally, the least closeness coefficient is 0.4713, which is the influence of friends (A2).

## CONCLUSION AND RECOMMENDATIONS

Based on the Fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) analysis, the most influential factor that affects the university selection is suitability with personality and interest. It means that most of the students choose to pursue their studies at a university that provides the course that they prefer according to their personality and interests. On the contrary, the influence of friends is the least important factor in university selection. Every student has their path in their life and it might not be the same with their friends. Furthermore, the study's finding shows small differences in each closeness coefficient value for each factor which means every factor should be considered by students in university selection. Future studies are recommended to add more alternatives (factors) to further expand the scope of the study and explore more new factors that might affect the university selection. These factors may change in the future due to more courses, new interests and preferences in the study, and the production of new technologies.

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## CONFLICT OF INTEREST DISCLOSURE

The authors declared that they have no conflicts of interest to disclose

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