FACTORS INFLUENCING STUDENTS’ CHOICE IN PURSUING TO HIGHER INSTITUTIONS: A FUZZY SET OPERATION APPROACH

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ABSTRACT
Choosing a suitable higher institution for pursuing students’ education is inevitably important. Many factors have to be considered so as to optimize the favorable environment of the students stay and learning. The factors are normally subjective in nature and difficult to evaluate tangibly. Fuzzy set theory is one of the approaches that can be used to cater this difficulty. In this paper, we evaluate and rank the main criteria that preferred by students in making their decision in choosing a university in Malaysia to pursue their study. Those criteria are reputation, location, programs offered, fees, size of university, scholars and loan, intake regulation, campus facilities and campus environment. A questionnaire is distributed using convenient sampling to a group of students and their responses are analyzed using fuzzy set operation. The method used is simple and applicable to the problem. It is found that the fee is the most considered criteria by students when choosing the university and the campus environment as the last criteria in the ranking. This investigation gives useful information as an input to strategize university planning in promoting and attracting more students to enroll at their university besides improving the service quality to the students.

Keywords: Fuzzy set operations, Higher institution, Decision making

1. INTRODUCTION
There is an increasing trend in Malaysia among the post secondary students to pursue their study to higher institutions, either to public universities or to private higher institution. According to the Ministry of Higher Education of Malaysia, as of 2007, there are twenty public funded universities and thirty seven private higher institutions in Malaysia. In terms of number of students, there are about 380,000 students enrol at public universities and this is slightly higher than the number of students enrol in higher private institutions which is about 365,000 students. The number is increasing from year to year. The choice whether to choose public or private varies from one person to another. Studies on which factors that influence students most in choosing particular university have been carried by some researchers such as Marta et al. [7], Marwan [8], Schimmel et al. [10], Shanka et al. [11], Sia [12] and Yasin et al. [13]. These studies on finding the relevant factors are important in the aspect that it will yield useful information for planning, promoting, monitoring and upgrading in order to ensure universities are able to satisfy the demand and expectation from the society [14].

Nevertheless, selecting the influenced factors in choosing a particular university is not an easy task as it involves human decision making process where basically there exist elements of vague, imprecise or subjective judgment. Due to these constraints, a method that can be suitably applied is the fuzzy set theory. The fuzzy set theory introduced by Zadeh [15] has been extensively used not just in solving engineering and industrial problems but also in management and social sciences in particular in decision making problems involving human perception. The application of fuzzy set theory in decision making was first discussed in Bellman & Zadeh [2] and later it was applied in many research areas. In particular, fuzzy AHP, fuzzy TOPSIS, fuzzy outranking method [3],[5],[9] are some of well known methods that have been introduced and can effectively deal subjective variables in the problems. Furthermore, due to its theoretical nature, one can also solve decision making by merely using the properties of fuzzy set ([1],[4],[6]). Çağman & Wang [4] applied simple fuzzy set operations in their methods to solve group decision making problems. Two types of results were produced by using the method. Firstly, the best alternative was identified among the considered alternatives and secondly was the screening of the decision makers where decisions that are categorized as outliers will be eliminated.

In this paper we identify the crucial factors that influence the choice of students in pursuing their study at a public university in Malaysia. As a case study, a group of students who have already registered at a well established public university in Malaysia were given a set of questionnaire for them to determine main factors of choice and furthermore rank the factors accordingly. In determining the best criteria, we implement a decision making method using Fuzzy set operation approach introduced by Çağman & Wang [4] since it is simple and effective to use. Based on the study by Yusof & Jemain [14], the criteria to be evaluated by the respondents are reputation, location, program offered, fees, size of university, scholars and loan offered, intake regulation, campus facilities and campus environment.
2. BASIC CONCEPTS
Some basic definitions and concepts will be given and the details of the methodology used are given in this section.

In a universe $U$, a fuzzy set $\tilde{A}$ as defined by Zadeh [15] is
\[
\tilde{A} = \{ (x, \mu_{\tilde{A}}(x)) : x \in U, \mu_{\tilde{A}}(x) \in [0,1] \}
\] (1)
where $\mu_{\tilde{A}}(x)$ is called a membership function. The value of the membership function denotes the degree or grade to any element $x$ in $U$. The followings are some concepts in fuzzy set operations that can be found in many references in fuzzy theory.

a) The support of $\tilde{A}$ is defined as
\[
supp\tilde{A} = \{ x : x \in U, \mu_{\tilde{A}}(x) > 0 \} .
\] (2)

b) The cardinality of crisp set $A$, denoted as $|A|$, is the number of elements of the set $A$, and the cardinality of a fuzzy set $\tilde{A}$ is defined as
\[
card\tilde{A} = \sum_{x \in U} \mu_{\tilde{A}}(x).
\] (3)

c) The mean relative cardinality of $\tilde{A}$ is defined as
\[
mcrc\tilde{A} = \frac{card\tilde{A}}{|supp\tilde{A}|},
\] (4)

d) The $\alpha$-level set (cut) of $\tilde{A}$ is defined as
\[
\tilde{A}_\alpha = \{ x : x \in U, \mu_{\tilde{A}}(x) \geq \alpha \},
\] (5)
where $\alpha \in [0,1]$.

3. METHODOLOGY
The methodology used is based on the procedure given by Çağman & Wang [4]. Students give their evaluations for all the considered factors according to their opinion in the form of membership grade of fuzzy set. Each of the criteria will be evaluated with a value in the interval $[0, 1]$ from the point of view of each student.

Let $A = \{ a_1, a_2, \ldots, a_n \}$, $B = \{ b_1, b_2, \ldots, b_m \}$ be the criteria set the student set in a finite universe $U_a$ and $U_b$, respectively. The following steps are to be adhered.

Step 1:
Let $b_i(a) \in [0,1]$ be a value of student $b_i \in B_k$ for an alternative $a \in A$, where $B_k$ is a set in $k$-cycle and $B_1 = B$. Then, for all elements of $A$, each student $b_i$ gives his/her evaluations independently according to his/her own preference by a fuzzy set as
\[
\tilde{A}_{b_i} = \{ (a, \mu_{\tilde{A}_{b_i}}(a)) : a \in A, \mu_{\tilde{A}_{b_i}}(a) = b_i(a) \}
\] (6)
which is called the $b_i$-fuzzy set for $b_i \in B_k$.

Step 2:
Students $b_i \in B_k$ will evaluate $a$ using $\tilde{A}_{b_i}$ and is denoted by $b_i(a)$. The fuzzy mean set of $\tilde{A}_{b_i}$ in the $k$-cycle is obtained as
\[
\tilde{A}_{B_k} = \left\{ (a, \mu_{\tilde{A}_{B_k}}(a)) : a \in A, \mu_{\tilde{A}_{B_k}}(a) = \frac{1}{|B_k|} \sum_{b_i \in B_k} \mu_{\tilde{A}_{b_i}}(a) \right\}.
\] (7)
Step 3: 
For all \( b_k \in B_k \), the distances between the sets \( \tilde{A}_k \) and the sets \( \tilde{A}_k \) which are called the fuzzy distance sets in \( k \)-cycle are characterized by fuzzy sets

\[
\tilde{A}_k (b_k) = \left\{ a, \mu_{\tilde{A}_k}(b_k)(a) \right\} \text{ with } a \in A, \mu_{\tilde{A}_k}(b_k)(a) = \left| \mu_{\tilde{A}_k}(a) - \mu_{\tilde{A}_k}(a) \right|.
\]  

The closeness of each \( b_k \) fuzzy decision set \( \tilde{A}_k, b_k \in B_k \), to the fuzzy mean set \( \tilde{A}_k \) will be determined.

Step 4: 
By using (4) of each \( b_k \) fuzzy distance sets \( \tilde{A}_k(b_k) \), the student’s performance denoted as the student performance fuzzy set will be evaluated in the \( k \)-cycle as

\[
\tilde{B}_k = \left\{ b, \mu_{\tilde{B}_k}(b) \right\} \text{ with } b \in B_k, \mu_{\tilde{B}_k}(b) = 1 - mrc \tilde{A}_k(b).
\]  

The universal set \( B_k \) needs to deal with, in order to apply formula (1). In this step, the performance of the students shall be investigated. An evaluation of the performance of the student \( b \) in \( k \)-cycle will be denoted as \( \mu_{\tilde{B}_k}(b) \).

Step 5: 
Let \( s_k^2 = \frac{1}{n} \sum_{b_k \in B_k} \left( \mu_{\tilde{B}_k}(b_k) - mrc \tilde{B}_k \right)^2 \) be the sample variance where \( s_k \) is the sample standard deviation and \( n \) is the cardinality of \( \text{supp} \tilde{B}_k \). Then \( \alpha_k \) is given as

\[
\alpha_k = mrc \tilde{B}_k - s_k.
\]  

The subset \( B_k \) is obtained by using \( \alpha_k \) which is called the \( \alpha_k \)-level set and given as

\[
\tilde{B}_{\alpha_k} = \left\{ b : b \in B_k, \mu_{\tilde{B}_k}(b) \geq \alpha_k \right\}.
\]  

If \( \tilde{B}_{\alpha_k} \subset B_k \), then the process has to start \( (k+1) \)-cycle with \( B_{k+1} = \tilde{B}_{\alpha_k} \). The cycle is finished when \( \tilde{B}_{\alpha_k} = B_k \).

Step 6: 
The largest value of the fuzzy mean set is classified as the most important factors considered by the students using (7) in step 2. In addition, the reliable students who give responsible responses will be identified by evaluating the students’ performance on evaluation from step 4.

The procedure stops in the \( k \)-cycle. Then we can get the following results in the applications:

1. The fuzzy mean set \( \tilde{A}_B \) gives us the average evaluations of the criterion by the students. Therefore, this method will be used as a process of selecting the most important criteria from available criterion.
2. The students performance fuzzy set \( \tilde{B}_k \) gives us the performance evaluation of the students in the \( k \)-cycle as a process of choosing reliable students.
3. The evaluations of criterion from students in the set \( B - B_{\alpha_k} \) which inconsistent with the evaluations from other students are categorized as outliers and will be eliminated.

4. IMPLEMENTATION
We denote the considered factors of the students’ choice adapted from Yusof & Jemain [14] as

\[
\begin{align*}
a_1 &= \text{reputation} \\
a_2 &= \text{location} \\
a_3 &= \text{programs offered} \\
a_4 &= \text{fees} \\
a_5 &= \text{size of university}
\end{align*}
\]
\( a_5 = \) scholarship and loan offered
\( a_1 = \) intake regulation
\( a_3 = \) campus facilities and,
\( a_5 = \) campus environment.

As an illustration of the applicability of the method, the data is obtained from 30 students from the university. By implementing step 1 and step 2 of the method, we obtained the average membership from the evaluations of the respondents as

\[
\tilde{\lambda}_B = \{ (a_1, 0.71), (a_2, 0.65), (a_3, 0.72), (a_4, 0.83), (a_5, 0.79), (a_6, 0.65), (a_7, 0.70), (a_8, 0.66), (a_9, 0.67) \}
\]

The fuzzy distance sets in 1-cycle which are obtained by using (8) and by using (9) as

\[
\sim B_1 = \{ (b_1, 0.94), (b_2, 0.79), (b_3, 0.87), (b_4, 0.85), (b_5, 0.8), (b_6, 0.84), (b_7, 0.87), (b_8, 0.78), (b_9, 0.74), (b_{10}, 0.79), (b_{11}, 0.84), (b_{12}, 0.88), (b_{13}, 0.83), (b_{14}, 0.88), (b_{15}, 0.87), (b_{16}, 0.87), (b_{17}, 0.86), (b_{18}, 0.82), (b_{19}, 0.93), (b_{20}, 0.87), (b_{21}, 0.85), (b_{22}, 0.88), (b_{23}, 0.8), (b_{24}, 0.86), (b_{25}, 0.88), (b_{26}, 0.86), (b_{27}, 0.86), (b_{28}, 0.77), (b_{29}, 0.75), (b_{30}, 0.81) \}
\]

The value of \( \alpha_1 = 0.79 \) is obtained by using (10). Hence, by using (11), \( \alpha_1 \)-level set is obtained as

\[
\tilde{B}_2 = \{ b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_{10}, b_{11}, b_{12}, b_{13}, b_{14}, b_{15}, b_{16}, b_{17}, b_{18}, b_{19}, b_{20}, b_{21}, b_{23}, b_{24}, b_{25}, b_{26}, b_{27}, b_{29} \}
\]

and students \( b_8, b_9, b_{22}, b_{29} \) are eliminated from the list since \( \mu_{\tilde{B}_2} < \alpha_1 \). The 2-cycle procedure will be used with \( B_2 = \tilde{B}_{a_1} \) since \( \tilde{B}_{a_1} \subset B_1 \).

We now continue to the 2-cycle procedure, the same procedure as \( B_2 \) with the same criteria set \( A \). In this 2-cycle, we obtained the value \( \alpha_2 = 0.81 \) this time around, 4 students \( b_5, b_{10}, b_{23}, b_{30} \) are eliminated since their values of \( \mu_{\tilde{B}_2} \) is less than \( \alpha_2 \). Since \( \tilde{B}_{a_2} \subset B_2 \), the procedure has to continue to 3-cycle with \( B_3 = \tilde{B}_{a_2} \) using

\[
\tilde{B}_3 = \{ b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_{10}, b_{11}, b_{12}, b_{13}, b_{14}, b_{15}, b_{16}, b_{17}, b_{18}, b_{20}, b_{21}, b_{22}, b_{23}, b_{24}, b_{25}, b_{26}, b_{27} \}
\]

we obtained the value of \( \alpha_3 = 0.84 \) and at this cycle, 3 students \( b_2, b_6, b_{18} \) are eliminated since their values of \( \mu_{\tilde{B}_3} \) is less than \( \alpha_3 \). Then the procedure has to start 4-cycle with \( B_4 = \tilde{B}_{a_3} \) since \( \tilde{B}_{a_3} \subset B_3 \). The procedure stops at 4-cycle since \( \tilde{B}_{a_4} = B_4 \). The \( \alpha \) value at this stage is 0.84 and no \( \mu_{\tilde{B}_{a_4}} \) is less than \( \alpha_4 \).

We finally obtained a set of membership value for each of the factors considered as

<table>
<thead>
<tr>
<th>Factors</th>
<th>Rating (membership value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( a_1 = ) reputation</td>
<td>0.73</td>
</tr>
<tr>
<td>( a_2 = ) location</td>
<td>0.64</td>
</tr>
<tr>
<td>( a_3 = ) programs offered</td>
<td>0.76</td>
</tr>
<tr>
<td>( a_4 = ) fees</td>
<td>0.86</td>
</tr>
<tr>
<td>( a_5 = ) size of university</td>
<td>0.77</td>
</tr>
<tr>
<td>( a_6 = ) scholarship and loan offered</td>
<td>0.65</td>
</tr>
<tr>
<td>( a_7 = ) intake regulation</td>
<td>0.75</td>
</tr>
<tr>
<td>( a_8 = ) campus facilities</td>
<td>0.63</td>
</tr>
<tr>
<td>( a_9 = ) campus environment</td>
<td>0.63</td>
</tr>
</tbody>
</table>

5. RESULTS AND DISCUSSIONS
When the procedure stops, it shows that the criteria \( a_4 \) (fees) has the largest membership value of \( \alpha_4 = 0.86 \). Thus, it is selected as the most important criteria when considering the university in this study as the place of choice followed by in ascending order, size of university, programs offered, intake regulation, reputation, scholars and
loans, location, campus facilities and campus environment. The last two factors are equal in the evaluation. It is also observed that $a_4$ (fees) has the largest membership value in all 1-cycle, 2-cycle, 3-cycle and 4-cycle. There was no elimination in the 4-cycle and hence, the procedure stops. Therefore, we can determine the best decision-maker, which is among all of the students. Student with the largest value of membership grade would be entitled as the best decision-maker. As a result, we obtained that student $b_{19}$ is the best decision-maker since 0.93 is the largest value. In each cycle of the evaluation, some of the evaluations are eliminated since the value of $\mu_{b_i}$ is less than $a_i$ until it stops at 4-cycle. The eliminated students are considered as the outlier decision-maker and their evaluations for the criteria have been discarded. The outlier students are $b_1, b_9, b_{28}, b_{29}$ in the 1-cycle, $b_5, b_{10}, b_{23}, b_{30}$ in the 2-cycle and $b_2, b_8, b_{18}$ in the 3-cycle. At the end of the 4-cycle, the number of students left were 19 students.

6. CONCLUSIONS
As intense competitions exist among universities to get more students to enrol to their institutions, it is imperative to know what factors students normally consider in choosing an institution. This study would be beneficial in order to improve their competitiveness among their rivals. This competitiveness could result an increase of applicants enrolling at the university. Fuzzy sets operation approach was used as a decision making method in this study and give a reasonable result as it can cater subjectivity of the data. Besides, this approach also helps to eliminate in the evaluation the so called outlier decision makers. This elimination serves the purpose of having a more accurate and reliable result. In this study, the fees turned out to be the most influenced factor for the students to choose the university in pursuing their study. As a recommendation, the authority of the university should consider in maintaining the existing fees as its main feature to attract more students. Furthermore the university should also enhance its marketing and promoting strategies based on the crucial factors above. This study can be extended to all universities in Malaysia and some comparative analysis can be made on the crucial factors between public universities and private institutions or even between each institution.

7. REFERENCES