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Bachelor Program and University Selection for STPM Leavers using TOPSIS

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Graphical abstract

Abstract

Choosing an appropriate bachelor program and university is a common scenario. In Malaysia, one major group of bachelor program prospect students is Sijil Tinggi Persekolahan Malaysia (STPM, Malaysian High School Certificate) leavers. The prospect students made the selection based on several factors, including the requirement by the university, personal preferences, and influences by parents, teachers, and peers. The decision made is normally unstructured and bias due to the personal preferences and the influencers. This research aims to study "Technique for Order Preference for Similarity to an Ideal Solution" (TOPSIS) from the multiple attribute decision making (MADM) method family in assisting the STPM leavers in choosing the program and university. Decision criteria are obtained from a group of STPM students (domain experts). The actual requirement from twenty Malaysian public universities and STPM results are used to illustrate the application of the proposed method. The illustrative experiments and results of the study have successfully shown the ranked alternatives.

Keywords: Fuzzy TOPSIS; prospect students; selecting university; STPM; university criteria

Abstrak

Proses memilih program sarjana muda dan universiti merupakan suatu senario yang biasa dilihat. Di Malaysia, satu kumpulan utama yang menjadi calon pelajar program sarjana muda ialah lepasan-lepasan Sijil Tinggi Persekolahan Malaysia (STPM). Calon-calon pelajar ini biasanya membuat pemilihan berdasarkan beberapa faktor, termasuklah syarat-syarat kemasukan universiti, pilihan peribadi, dan pengaruh daripada ibu bapa, guru, dan rakan-rakan. Oleh kerana itu, keputusan yang dibuat adalah bersifat tidak berstruktur dan berat sebelah. Kajian ini adalah bertujuan untuk mengkaji "Technique for Order Preference for Similarity to an Ideal Solution" (TOPSIS) yang merupakan sub-kaedah kepada kaedah pembuatan keputusan berasaskan pelbagai atribut (MADM) dalam membantu lepasan STPM memilih program dan universiti. Kriteria pemilihan diperoleh daripada sekumpulan pelajar-pelajar STPM. Syarat-syarat kemasukan daripada dua puluh universiti awam tempatan dan keputusan STPM sebenar digunakan untuk menggambarkan aplikasi kaedah yang dicadangkan. Eksperimen dan keputusan kajian ini telah berjaya menunjukkan alternatif yang disusun mengikut kedudukan.

Kata kunci: Fuzzy TOPSIS; calon pelajar; pemilihan universiti; STPM; kriteria university

1.0 INTRODUCTION

Sijil Tinggi Persekolahan Malaysia (STPM) or in English; Malaysian Higher School Certificate, is one of the pre-university examinations in Malaysia. Formerly, it was known as Higher School Certificate (HSC) and it was equivalent to the GCE A levels examination in the United Kingdom, Australia, and many other Commonwealth countries. STPM examination is managed and run by Malaysian Examination Council since 1982 under the Ministry of Education, while other examinations are run by the Department of Examination, Ministry of Education[1]. It is internationally recognized by many universities especially in the UK and those countries within the Commonwealth of Nations.

As a pre-university course, STPM is used by its leavers to track the appropriate university to pursue the tertiary education. While evaluating the university, the STPM leavers keep several influences and criteria with them. Value and reputation of education in each university, the programme structure, conducive facilities, reachable information, parents, teacher, and others' influence and customer orientation of the university are considered by the prospect university students[2]. Furthermore, the proximity from home is one of the most influenced criteria[3]. Those criteria have made the university selection process is complex. In addition, the decision made is also considered as a long-life decision and mostly affect the students' life[4]. The choice made can influence the student's future career, friendships, future residence and personal satisfaction[5].

As the university selection contributes effects on a person's life, the decision made by STPM leavers must be accurate. A systematic approach is needed due to the decisions made in this stage will affect the future career of a STPM leavers[6]. Therefore, the research focuses on how to assist the STPM leavers in making better and precise decision without leaving behind the personal preferences and specific university criteria using a structured mathematical method. To make it clear and achievable, we propose a method from multiple attribute decision making (MADM) family, "Technique for Order Preference for Similarity to an Ideal Solution" (TOPSIS) to calculate the weight of each criterion and to rank the alternatives – programs and universities. The rest of this research is investigating the effectiveness and reliability of TOPSIS in ranking the programs and universities based on several attributes or criteria.

The university criteria evaluated in this research is surveyed earlier, where 297 STPM students have involved[7]. The most considered criteria resulted from the survey are used in the calculation of this research. In addition, the alternatives available are the collection of all bachelor programs in Malaysian public universities (updated in 2012).

Due to the various criteria existed, the decision in selecting the right university is a tough and complex process. Decision is defined as a choice between two or more alternatives[8], or reasoned choice among alternatives[9]. Alternatives are all the possible decision or an output a decision maker can choose at the end of the decision making process. If there is only one alternative, then, the decision maker does not have to make a choice, therefore, there will be no decision.

Decision has its own features; the statement of problem, the alternatives, and the decision making criteria[9]. A good decision is the end result of carefully selecting the alternatives process after studying of what might happen[8a]. The good decision relies on two factors; the risks and the decision maker's personal values. The decision maker's value is stated as subjective judgment. Some decisions are hard to make due to too many considerations or factors involved. The hardness leads to the needs of decision analysis. Decision analysis is a discipline that studies how to improve decision making. It also can be defined as a process on what decision to make. It involves precise and objective oriented mathematical calculations[8a]. Furthermore, decision analysis requires decision maker's personal judgement which is very important in making a good decision[10].

Decision analysis is applied in the decision support system in assisting the decision maker to make a better and precise decision. It utilizes data, provides an easy-to-use interfaces and allows for the decision maker's own insight. Forgionne[11] defines DSS as a process where the DM utilizes the computer technology to organize the data, attach the problem to a method, use the method to create a list of solutions or alternatives, and find the best solution for the problem. Decision support system requires users to choose the criteria and give the preferences. It produces the ranking that is personalized to its users. Aljunid *et al*.[12] developed a DSS that assists the Sijil Pelajaran Malaysia leavers (SPM/Malaysian Certificate of Education) that is equivalent to O level to choose the appropriate diploma program. The study put each of the subjects in the certificate as the main criteria, and uses fuzzy MADM method as the engine of the DSS.

Many of the DSS available have utilized multi-attribute decision making method (MADM). One of the popular methods in fuzzy MADM is fuzzy TOPSIS (Technique for Order Preference by Similarity to Ideal Solution). It is popular due to the straight forward calculation and easy to understand. The TOPSIS method was firstly pioneered by Hwang and Yoon in 1981[13]. It uses the Euclidean distances technique to rank the best alternatives[14]. Euclidean distances technique ranks the alternatives by measuring their distances from the ideal and the negative ideal solution. The best alternative simultaneously has the shortest distance from the ideal solution and the longest distance from the negative ideal solution). The ideal solution is identified with a possible alternative that has the best values for all criteria, whereas the negative ideal solution is identified with a possible alternative that has the worst values for all criteria[14a].

Due to its effectiveness, a huge number of studies have been carried out to revise and implement TOPSIS method. Wang and Lee[14a] implement this method to evaluate the needs of outsourcings the software. Dağdeviren *et al*.[14a] uses TOPSIS together with AHP in selecting the optimal weapon in Turkey. AHP is used to analyze the structure of the weapon and assigning the criteria weights, while TOPSIS is used to rank the alternatives. Sun and Lin[15] uses TOPSIS as the weight calculator and the ranking method in evaluating the competitive advantage of the shopping websites in Taiwan. Saremi *et al*.[16] apply TOPSIS in selecting the best TQM (total quality management) consultant. The study involves three DM (experts) and five criteria of desired consultant and find that TOPSIS is more appropriate to be used compared to other MADM methods in solving the selection problem. Gumus[17] applies TOPSIS together with AHP to evaluate the waste transportation firm to transport the hazardous waste. The alternative firms must follow the standard of USA Environmental Protection Agency (EPA). This study uses AHP to obtain the weight by applying the modified Delphi method, while TOPSIS is used to rank the alternatives. The study finds that the weight calculation by AHP and ranking by TOPSIS are reliable.

The remainder of this paper is organized as follow. In the next section, is a brief explanation of the proposed method-TOPSIS. Fifth section concentrates on the proposed method. A set of STPM results and personal preferences is used to test TOPSIS method. Next, one illustrated experiment is presented. The last section discusses the result of the experiment and concludes the work.

2.0 EXPERIMENTAL

2.1 Objective Weight

Motivated by the review of Lai *et al*.[18], Melon *et al*.[19], and Seçme *et al*.[20], which used AHP in calculating the weights, and Sun and Lin [15] which uses TOPSIS in calculating the weight, this study applies TOPSIS method of MADM in calculating the weights. It is selected because of the trust of its preciseness gained from previous literatures and the simple and straight forward calculation. The steps of calculation are based on[14a,21].

Before applying the method, a set of simple questionnaires is set up to obtain the fuzzy weight from domain experts (teachers). Teachers are selected because they are the expert in their domain[22]. The teachers are required to give weight of each attribute or criteria suggested in the questionnaires. The suggested criteria in choosing a programme and university are STPM examination result, field of interest, university criteria, and the most preferred university.

If there are any additional criteria, the experts can suggest them and assign the weight of important on them. The weight of importance is given by using the linguistic variables as follows.

Table 1 Fuzzy linguistic variable for each criteria 14a

Importance	Abbreviation	Fuzzy Number
Very low	VL	(0, 0, 0.2)
Low	L	(0.05, 0.2, 0.35)
Medium Low	ML	(0.2, 0.35, 0.5)
Medium	M	(0.35, 0.5, 0.65)
Medium High	MH	(0.5, 0.65, 0.8)
High	H	(0.65, 0.8, 0.95)
Very high	VH	(0.8, 1, 1)

Based on the fuzzy numbers, four experts are selected to give weights. The weights from four experts are aggregated by using multiplication operation as suggested Chou in Chamodrakas[21a]. Chou proved that if m=(a,b,c) and n=(d,e,f) are triangular fuzzy numbers, then the representation of the aggregation can be defined as,

$$P(m \otimes n) = m \times n \tag{1}$$

After the aggregated fuzzy number is obtained, the steps of TOPSIS take place. The first step is to calculate the distance from positive ideal solution and negative ideal solution as

$$S^* = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^*)^2} \tag{2}$$

$$S^- = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^-)^2} \tag{3}$$

where v* and v- are the maximum and minimum fuzzy number in the vertical line of decision matrix respectively. The second and last step is to calculate the closeness coefficient (CC) as

$$C^* = \frac{S_i^-}{S_i^* + S_i^-} \tag{4}$$

(4)

Then, the result C* for each criterion is assigned as the objective weight. Generally, any criterion or attribute that has larger value of weight compare to another has the higher degree of importance[23], and the weights must satisfy the condition of $\sum_{j=1}^{m} w_j = 1$[24].

2.2 Ranking the Alternatives

The calculation for the scores of the alternatives is done with TOPSIS as well. By referring to the previous studies[14a,15,21-22,25a], TOPSIS method starts at the normalization step. The decision matrix A is normalised into matrix B with element of r_{ij} by using Equation (5) and (6)[25b].

$$b_{mn} = \frac{a_{mn} - a_n^{min}}{a_n^{max} - a_n^{min}} \tag{5}$$

$$b_{mn} = \frac{a_n^{max} - a_{mn}}{a_n^{max} - a_n^{min}} \tag{6}$$

where a_{mn} is the matrix element (the score for each alternative against each criterion or attribute), a_n^{max} and a_n^{min} are the maximum and minimum score in the matrix row.

Then, the elements in the matrix need to be multiplied with the weight (w_j) of the attributes and the result of this calculation is assigned as v_{ij}. Next, by using the elements v_{ij} find the positive ideal solution A^* and the negative ideal solution A^-. The positive and negative ideal solution can be calculated as the following (7) and (8) equation, where J^1 is benefit attribute and J^2 is cost attribute. The benefit attributes are those with the condition of the higher score the better, while cost attributes are those with the condition of the lower score the better. In the study, the cost attribute is the STPM result against the minimum requirement score, and the benefit attributes are the field of interest, university criteria, and the preferred university.

$$A^* = \left\{ (\max_i v_{ij} \in J^1), (\min_i v_{ij} \in J^2) \right\} \tag{7}$$

$$A^- = \left\{ (\min_i v_{ij} \in J^1), (\max_i v_{ij} \in J^2) \right\} \tag{8}$$

The next procedure is to calculate the separation measures by using (9) and (10).

$$S^* = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^*)^2} \tag{9}$$

$$S^- = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^-)^2} \tag{10}$$

Where v_{ij} is the element in the normalized matrix, v_j^* is the positive ideal solution, and v_j^- is the negative ideal solution. Lastly, calculate the closeness coefficient (CC) by using (11). The scores produced are ranked in descending order. This denotes that the alternative with the highest score is the best one[14a,20].

$$CC_i = \frac{S_i^-}{S_i^* - S_i^-} \tag{11}$$

(11)

Another calculation involved is the scores for each alternatives selected against each of the subject in the STPM result. The calculation adopts the simple additive weighting method as in Equation 12.

$$a_{m1} = \sum_{k \geq 1}^{n} r_k q_n \tag{12}$$

where, rk represents the results and qn represents the minimum requirements for a certain programme.

3.0 RESULTS AND DISCUSSION

3.1 Objective Weights

TOPSIS is used to transform the fuzzy linguistic preferences (see Table 1) from four domain experts (or STPM teachers) into an objective number. The first step is to collect all preferences from experts on every main criterion evaluated in this study. The preferences given by each expert for each criterion is shown in Table 2, where C1 is results attribute, C2 is field of interest or programme attribute, C3 is the university criteria attribute and C4 is the preferred university attribute, while Dn is the number of experts involved.

The multiplied scores in Table 3 are calculated by using (1). Then, the numbers are used to find the separation from positive ideal solution (PIS – S*) and the negative ideal solution (NIS – S-). Those PIS and NIS are computed by using (2) and (3) respectively. Lastly, the closeness coefficient for each criterion is calculated by using (4). Then, the weights obtained from this process is 0.5 for STPM results, 0.3 for field of interest, 0.15 for university criteria, and 0.05 for preferred university.

Table 2 Weights for each criterion given by each expert

Criteria (C)	D1	D2	D3	D4
C1	H	VH	H	H
C2	MH	MH	H	MH
C3	M	MH	H	ML
C4	ML	M	MH	L

Table 3 The calculation for weights in TOPSIS

Criteria	Multiplication of fuzzy number	S*	S-	C*
C1	(0.2197,0.5120,0.8574)	0.5377	0.5903	0.5
C2	(0.0813,0.2197,0.4864)	0.7565	0.3117	0.3
C3	(0.0228,0.0910,0.2470)	0.8847	0.1525	0.15
C4	(0.0018,0.0228,0.0910)	0.9623	0.0541	0.05

3.2 Ranking the Alternatives

The scores of the weight for main criteria are used in the ranking calculation. A DSS is exclusively built for the STPM leavers in Malaysia. As in Figure 1, the state field in the database (Lokasi) contains the name of the states, the distance between each state, and the proximity from a state to others in linguistic variable form like very far, far, and near. This linguistic variable is turned into fuzzy number and it is used in the calculation for the university criteria.

Figure 1 Example of the input

The 'stream' field (Aliran STPM) in the database is used to store the stream name and the list of the subjects for each stream. Thus, if a user selects Science (Sains) stream, only the subjects related to Science stream will be displayed. The same thing will happen if user selects Art (Kemanusiaan) stream. Then, user is displayed with the next page as in Figure 2.

As in Figure 2, the subject of "Pengajian Am" is compulsory for all STPM students and other subjects are selective. In this example, the subjects and grades as in Figure 2 have been selected. The pointer for each grade is displayed automatically after each grade is keyed in.

Figure 2 STPM result page

Then, the user is shifted to the third page (see Figure 3 and 4), that contain fields of interest or desired programmes selection. By selecting the field (Bidang) user is displayed all of the qualified programmes within the particular field. User can select one or two related fields.

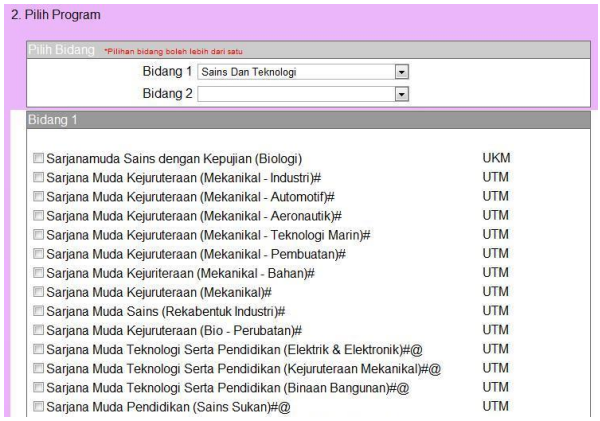

Figure 3 Top of alternatives page

Figure 4 Bottom of alternatives page

The programmes selected are the alternatives evaluated in the fuzzy TOPSIS engine. Therefore, not all programmes from all universities are evaluated. User can select as many programmes as he/she wants. However, it is advisable to select maximum eight programmes as suggested in the Malaysian on-line university application form.

"Pilih Program" button leads user to the next page (Figure 5 and 6) that displays all the programmes selected, the university criteria, and list of universities chosen which require user to give preferences and weights. There are only three preferences in linguistic variable form for programmes and universities attributes. The linguistic variables are strongly interested (*sangat minat*), interested (*minat*), and average (*sederhana*). Only three variables are used based on the assumption, if the user has no interest on a programme and university, he or she initially will not select the programme and university, while there are five preferences for university criteria; strongly important (sangat penting), important (*penting*), average (*sederhana*), unimportant (*tidak penting*), and strongly unimportant (*sangat tidak penting*).

Figure 5 Preferences on the programmes and university criteria

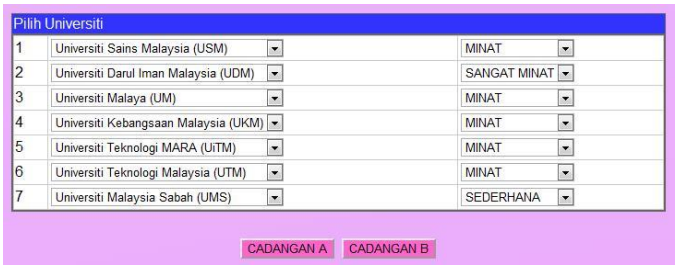

Figure 6 Preferences on selected universities

For the purpose of empirical example, the preferences for each attributes are given as shown in Figure 5 and Figure 6. Each of preference represents certain scores that are initially stored in the database. The scores are the numbers calculated earlier outside the system based on the fuzzy linguistic variables against the features (sub-criteria for university criteria) of the alternatives (universities). All of the scores are stored in the temporary tables in the database for calculation purposes. For this example, when user click on button "Cadangan B" which represents TOPSIS method the following calculation and process are run by the system.

As stated previously, all of the information from user is stored in the tables in database. The first data stored in the database are the user's results pointer and the place of origin. All the STPM results are transformed into scores as in Table 4. The scores are calculated by using formula (12) and normalized with (6).

The preferences on the alternatives selected are considered as the preference on the field of interest (see Figure 5 and Table 5). The preferences on university criteria from the example (Figure 5) are transformed into scores as shown in Table 6. The normalized scores for preferences on field of interest and preferences on university sub-criteria are calculated by using Equation (5).

Table 4 STPM results against minimum requirements score and normalized score.

Alternatives	Results score against minimum requirements	Normalized result score
Sarjana Muda Sains dengan Kepujian (Biologi) – UKM	30.02	0.63
Sarjana Muda Sains (Rekabentuk Industri) – UTM	28.05	0.72
Sarjana Muda Sains (Fizik) – UiTM	37.85	0.30
Sarjana Muda Sains Kesihatan (Patologi Pertuturan) – USM	45.03	0.00
Sarjana Muda Sains (Kimia) – UM	30.03	0.63
Sarjana Muda Sains Makanan dan Pemakanan – UMS	21.34	1.00
Sarjana Muda Teknologi Makanan – UDM	33.87	0.47

Table 5 Preferences on field of interest (programmes or alternatives) and normalised scores.

Alternatives	Preference score	Normalized Score
Sarjana Muda Sains dengan Kepujian (Biologi) – UKM	0.2	0.00
Sarjana Muda Sains (Rekabentuk Industri) – UTM	0.3	0.33
Sarjana Muda Sains (Fizik) – UiTM	0.2	0.00
Sarjana Muda Sains Kesihatan (Patologi Pertuturan) – USM	0.3	0.33
Sarjana Muda Sains (Kimia) – UM	0.2	0.00
Sarjana Muda Sains Makanan dan Pemakanan – UMS	0.5	1.00
Sarjana Muda Teknologi Makanan – UDM	0.5	1.00

Table 6 Scores for each university sub-criterion for each alternative.

Alternatives	C1	C2	C3	C4	C5	C6	C7
UKM	**0.6261**	**0.2942**	**0.00**	**0.5055**	**0.00**	**0.6282**	**0.00**
UTM	0.6261	0.2942	0.00	0.5055	0.00	0.00	0.3688
UiTM	0.6261	0.3688	0.00	0.5055	0.00	0.00	0.00
USM	0.6261	0.2942	0.00	0.5055	0.6282	0.6282	0.00
UM	0.6261	0.2942	0.00	0.5055	0.00	0.6282	0.00
UMS	0.2945	0.2942	0.00	0.5055	0.00	0.00	0.00
UDM	0.2945	0.2942	1.00	0.2942	0.00	0.00	0.3688

Table 7 Normalised scores for university sub-criteria

Alternatives	C1	C2	C3	C4	C5	C6	C7
UKM	1.0	0.0	0.0	1.0	0.0	1.0	0.0
UTM	1.0	0.0	0.0	1.0	0.0	0.0	1.0
UiTM	1.0	1.0	0.0	1.0	0.0	0.0	0.0
USM	1.0	0.0	0.0	1.0	1.0	1.0	0.0
UM	1.0	0.0	0.0	1.0	0.0	1.0	0.0
UMS	0.0	0.0	0.0	1.0	0.0	0.0	0.0
UDM	0.0	0.0	1.0	0.0	0.0	0.0	1.0

Table 8 Aggregated university criteria, scores for preferred university and their normalised scores

Alternatives	Aggregation of university criteria	Preferred university scores	Normalized preferred university scores
UKM	0.4286	0.3	0.33
UTM	0.4286	0.3	0.33
UiTM	0.4286	0.3	0.33
USM	0.5714	0.3	0.33
UM	0.4286	0.3	0.33
UMS	0.1429	0.2	0.0
UDM	0.2857	0.5	1.0

Table 9 Normalised decision matrix.

Alternatives	C1	C2	C3	C4
UKM	0.63	0.00	0.4286	0.33
UTM	0.72	0.33	0.4286	0.33
UiTM	0.30	0.00	0.4286	0.33
USM	0.00	0.33	0.5714	0.33
UM	0.63	0.00	0.4286	0.33
UMS	1.00	1.00	0.1429	0.00
UDM	0.47	1.00	0.2857	1.00
Weights	0.5	0.3	0.15	0.05

Table 10 Weighted decision matrix, PIS, and NIS.

Alternatives	C1	C2	C3	C4
UKM	0.315	0.00	0.0643	0.0165
UTM	0.36	0.099	0.0643	0.0165
UiTM	0.15	0.00	0.0643	0.0165
USM	0.00	0.099	0.0857	0.0165
UM	0.315	0.00	0.0643	0.0165
UMS	0.50	0.30	0.0214	0.00
UDM	0.235	0.30	0.0429	0.05
PIS (A*)	0.50	0.30	0.0857	0.05
NIS (A-)	0.00	0.00	0.0214	0.00

Positive ideal solution (PIS) scores are obtained by using Equation (7) while negative ideal solution (NIS) scores in Table 10 are gained from Equation (8). PIS and NIS are used to calculate the positive separation measures (S*) and negative separation measures (S-). Positive and negative separation measures are calculated by using Equation (9) and (10) respectively. Then, they are used to calculate the final score in TOPSIS; the closeness coefficient (CC*) as in Equation (11). Table 11 shows all the scores for positive and negative separation measures together with the closeness coefficient. The last step is to rank the score in descending order as shown in Figure 7.

Table 11 Separation measures, and closeness coefficient (final score)

Alternatives	S*	S-	CC*
UKM	0.3547	0.3183	0.473
UTM	0.2482	0.3762	0.6025
UiTM	0.4627	0.1569	0.2532
USM	0.5399	0.1192	0.1808
UM	0.3547	0.3183	0.473
UMS	0.0814	0.5831	0.8774
UDM	0.2684	0.3849	0.5892


CADANGAN B

Senarai Cadangan Program Dan Universiti adalah:

Bil	Program	Universiti
1	Sarjana Muda Sains Makanan dan Pemakanan	Universiti Malaysia Sabah (UMS)
2	Sarjana Muda Sains (Rekabentuk Industri)#	Universiti Teknologi Malaysia (UTM)
3	Sarjana Muda Teknologi Makanan#	Universiti Darul Iman Malaysia (UDM)
4	Sarjanamuda Sains dengan Kepujian (Biologi)	Universiti Kebangsaan Malaysia (UKM)
5	Sarjana Muda Sains (Kimia)	Universiti Malaya (UM)
6	Sarjana Muda Sains (Fizik)	Universiti Teknologi MARA (UiTM)
7	Sarjana Muda Sains Kesihatan (Patologi Pertuturan)	Universiti Sains Malaysia (USM)

CETAK

Figure 7 Final suggestion using TOPSIS method

4.0 CONCLUSION

Based on the experiment result, TOPSIS is successfully used in calculating the objective weight. The weights are gained from the preferences collected from the experts by using the linguistic variables. The preferences are transferred into fuzzy numbers and have been successfully transformed into objective numbers by following the simplified TOPSIS method. The other issue is that TOPSIS has successfully ranked all of the alternatives according to the preferences given by the user and the objective weight calculated (see Table 11 and Figure 7).

The first rank of the alternatives (UMS) received the highest score of the STPM result and field of interest attributes and low scores of university criteria and preferred university attributes. The second place (UTM) received high score for STPM result as well, and medium scores of the field of interest, university criteria, and preferred university criteria. The last two places are UiTM and USM, where UiTM receives low scores of STPM results and field of interests, preferred university attributes, and high scores of university criteria. USM receives low scores of STPM results, the field of interest, and preferred university while high score is received from the university criteria attribute.

From the explanation above, the result has shown a pattern of ranking. It considers the STPM result at the first place follows by field of interest, university criteria, and preferred university respectively, which is parallel to the weight of preferences given by the experts. Logically, the result is following the rules set up in the TOPSIS engine, and the weight calculated also by using TOPSIS has been effectively utilized in the calculation. As the investigation of TOPSIS method has shown the successful result, it can be concluded that TOPSIS is an effective and dependable method in the case of ranking the university programs and universities with multiple decision maker's personal preferences.

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