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An evaluation of students performance using TOPSIS and Entropy approaches

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Abstract: *This study uses techniques for order preference by similarity to ideal solution (TOPSIS) combined within formation entropy weight to investigate the performance of 20 students. Assessments in teaching and research and development ability reflect the short-term and long-term performance. Exact values and intervals characterize the attribute values in the current model. A comparison and experimental analysis show the applicability, feasibility, effectiveness, and advantages of the proposed method. In this study focused on the TOPSIS and Entropy to calculate the student's performance. First, in this case, study the logic of TOPSIS conferring to the standard decision theory. It appearances that TOPSIS also has a built-in multi-attribute value function that not revealed explicitly. So far, this has been a hidden feature of TOPSIS. Second, Entropy applied for the decision maker's (DM) behavioral propensity into TOPSIS. Finally, to improve evaluation accuracy of student performance, TOPSIS and Entropy applied to ranking the student with several criteria such as Presence (C1), Participation in Class (C2), Individual Assignment (C3), Group Assignment (C4), Quiz (C5), Midterm-Exam (C6), and Final Exam (C7).*

Keywords – *Evaluation, Entropy, Performance, Student, TOPSIS*

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I. Introduction

The main tasks of the teacher associated with supervising the student on the progress of the knowledge development. The supervision reports of educational development projects are prepared annually, based on the student performance, with the purpose of intention the ranking for the student. The academic is basis for the implementation of sustainable development principles and coevolution ideas[1]. Teachers are one of the essential human resources and hugely influential on the quality of education, especially in realizing quality education. Numerous specialists in educational sciences are focusing their attention on the effectiveness of the educational styles[2]. Teachers have a significant and essential role in realizing accountability of the provision and delivery of quality education services.

Without a qualified teacher, efforts to improve the quality of education will be proficient outstandingly. Teachers have a considered role in guiding, directing, and educating students in the learning process. Teachers have a more prominent role in creating quality teaching and learning process. Where the eminence or not the process of teaching and learning accomplishments should be studied from the influences of qualification and performance of teachers. The performance of qualified teachers will improve the excellence of education in schools [3]. A constructive correlation between attitude and motivation was also determined, and it determined that the correlation is higher in academic formation students[4].

Besides, among the multiple approaches to conflict management, Multi-Criteria Decision-Making (MCDM) is very common. MCDM process can be a complex and dynamic process also at the decision-making level. Referable to the above limitation, in this paper TOPSIS methodology will be used to resolve student performance in order to identify the best option. The Entropy approach will be inserted in TOPSIS procedure with the objectives to provide alternatives for weight scoring ranking process. Another study uses techniques for order preference by similarity to ideal solution (TOPSIS) combined with information entropy weight (IEW), to investigate the performance of 68 Chinese universities belonging to the Ministry of Education (MOE) from 2002 to 2011[5].

The straightforward in impression the capability of TOPSIS to deal with a large number of attributes as an ideal alternative have the shortest distance from the positive ideal solution and the farthest from the negative ideal solution[6]. Among the advantages of TOPSIS are logically represent the rationale of human choice by considering both the best and the worst attributes of alternatives simultaneously, represented by a scalar value, the simplicity of computation and presentation. The number of attributes does not influence the number of steps. Thus it offers a faster solution[7]. In recent years, TOPSIS successfully applied as decision-making tools to

different areas including management[8], manufacturing[9], engineering[10], agriculture[11] and education[12]. However, in this study focus on education management to evaluate the student's performance using TOPSIS and Entropy approaches.

II. Methodology

The design and solicitation of Multi-Criteria Decision Making (MCDM) approaches have been a producer in several research fields. For example, a matter of circumstance terminated the improvement of the several decades; a variety of different MCDM has been developed and empirically employed in field research. Decision making is the study of identifying and selecting alternatives based on the values and preferences of the decision maker. A decision-making matrix applied as one of the powerful tools for decision process designed based on a rectangular array of basics decided in rows and columns.

The popular MCDA methodology is Technique for Order Performance by the Similarity to Ideal Solution (TOPSIS) proposed by Hwang and Yoon in 1981 and used in many application areas. This methodology was originally designed for solving ranking problems. In fact, TOPSIS provides a ranking of alternatives based on similarity scores, where the similarity score of each alternative is a function of the distances between the alternative and a couple of benchmarks commonly referred to as the positive and the negative ideal solutions.

Besides, the Entropy Weight Method (EWM) is based on Shannon entropy, originally developed by Shannon and Weaver, in 1947. Shannon entropy is a conception which is recommended as a measure of uncertainty in information, expressed in terms of possibility theory. In this paper, the process of the TOPSIS begins to make original data matrix by using criteria value for each alternatives.

Step 1. Build the original data evaluation matrix

$$D=\left[x_{ij}\right]_{m\times n}=\begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array}\begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}_{m\times n} \end{array}$$

$$i=1,2,\ldots,m\ ,\ j=1,2,\ldots,n \tag{1}$$

Step 2. Normalized original matrix

$$r_{ij}=\frac{x_{ij}}{\sqrt{\sum_{i=1}^{m}x_{ij}^2}}$$

$$i=1,2,\ldots,m\ ,\ j=1,2,\ldots,n \tag{2}$$

$$R=\left[r_{ij}\right]_{m\times n}=\begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array}\begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}_{m\times n} \end{array}$$

$$i=1,2,\ldots,m\ ,\ j=1,2,\ldots,n \tag{3}$$

Step 3. Calculate the objective weight with Entropy

$$e_j=-\frac{1}{\ln m}\sum_{i=1}^{m}r_{ij}\ln r_{ij}$$

$$i=1,2,\ldots,m\ ,\ j=1,2,\ldots,n \tag{4}$$

Recalculate the weight of each evaluation criterion

$$W = (w_1, w_2, ..., w_n)$$

$$w_j = \frac{1-e_j}{\sum_{j=1}^{n}(1-e_j)}$$

$$i = 1, 2, \ldots, m \ , \ j = 1, 2, \ldots, n \tag{5}$$

Step 4. The weight matrix

$$v_{ij} = r_{ij} \times w_j \tag{6}$$

$$V = \left[v_{ij} \right]_{m \times n}$$

$$i = 1, 2, \ldots, m \ , \ j = 1, 2, \ldots, n \tag{7}$$

Step 5. Calculate positive and negative ideal solutions

$$V^+ = \left\{ v_1^+, v_2^+, ..., v_n^+ \right\} \tag{8}$$

$$V^- = \left\{ v_1^-, v_2^-, ..., v_n^- \right\} \tag{9}$$

Step 6. Calculate the distance between the evaluated sample and the positive and negative ideal solutions

$$S_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^+ \right)^2}$$

$$i = 1, 2, \ldots, m \ , \ j = 1, 2, \ldots, n \tag{10}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^- \right)^2}$$

$$i = 1, 2, \ldots, m \ , \ j = 1, 2, \ldots, n \tag{11}$$

Step 7. Calculate the relative performance indicator value (Performance Index)

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-} \tag{12}$$

Step 8. Sorting (Ranking)

According to the relative proximity value of each Ci evaluation sample, it is the relative pros and cons of each evaluation sample after evaluation. $0 < C_i < 1$, C_i the closer the value is to 1, the closer the evaluation sample is to the positive ideal solution; it also means that under the existing evaluation criteria, the evaluation illustration is the best evaluation sample relative to other evaluation samples. Conversely, if C_i the values are farther apart from each other, it means that the evaluation sample is a poor evaluation sample and there is considerable room for improvement.

III. Research Findings And Evaluation

Before commencing the study, ethical clearance obtained from a mathematical program developed for this reason enables one to obtain the weighted entropy coefficients and the output of the TOPSIS method. It points out that the material indices considered above in Table 1 are assumed to be independent measures of the corresponding each parameter of performance. Presence (C_1), Participation in Class (C_2), Individual Assignment (C_3), Group Assignment (C_4), Quiz (C_5), Midterm-Exam (C_6), and Final Exam (C_7). As such, this study has prompted important questions for future research around students' performance and the teacher method to calculate the student performance.

The goal is to optimize each index, regardless of the values of individual material properties defined in that index. Furthermore, the initial optimum value of each criterion is independent of other criteria values (i.e., no interaction is acceptable). However, when these criteria used with the TOPSIS method which cannot treat the material properties as individual criteria, the ranking results obtained in this work might not be susceptible to the inclusions of indices. The analyst provides seven measures of criteria to calculate the student's performance. The most compelling finding is that the actual weight calculated with step 3 equation by Entropy showed in Table 2.

Table 1. The weighted normalized matrix of student's performance

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
S_1	0.235	0.227	0.249	0.219	0.211	0.222	0.223
S_2	0.235	0.241	0.222	0.224	0.225	0.235	0.226
S_3	0.235	0.227	0.222	0.219	0.231	0.209	0.212
S_4	0.235	0.227	0.247	0.219	0.217	0.183	0.239
S_5	0.235	0.213	0.194	0.230	0.219	0.214	0.204
S_6	0.235	0.227	0.194	0.224	0.225	0.229	0.220
S_7	0.211	0.227	0.249	0.219	0.211	0.222	0.218
S_8	0.188	0.241	0.222	0.224	0.225	0.235	0.226
S_9	0.235	0.213	0.222	0.230	0.231	0.209	0.212
S_{10}	0.188	0.227	0.247	0.219	0.217	0.261	0.239
S_{11}	0.235	0.213	0.222	0.230	0.219	0.214	0.204
S_{12}	0.235	0.227	0.194	0.224	0.225	0.229	0.234
S_{13}	0.235	0.227	0.249	0.219	0.211	0.222	0.247
S_{14}	0.188	0.241	0.222	0.224	0.225	0.235	0.218
S_{15}	0.235	0.198	0.222	0.219	0.231	0.209	0.212
S_{16}	0.188	0.227	0.247	0.219	0.217	0.261	0.212
S_{17}	0.235	0.213	0.194	0.230	0.219	0.214	0.252
S_{18}	0.235	0.198	0.194	0.224	0.225	0.229	0.204
S_{19}	0.211	0.227	0.222	0.230	0.259	0.222	0.220
S_{20}	0.235	0.227	0.222	0.224	0.225	0.209	0.239

Table 2. The objective weight with Entropy

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
S_1	-0.340	-0.337	-0.346	-0.333	-0.328	-0.334	-0.335
S_2	-0.340	-0.343	-0.334	-0.335	-0.336	-0.340	-0.336
S_3	-0.340	-0.337	-0.334	-0.333	-0.338	-0.327	-0.329
S_4	-0.340	-0.337	-0.345	-0.333	-0.331	-0.310	-0.342
S_5	-0.340	-0.329	-0.318	-0.338	-0.333	-0.330	-0.325
S_6	-0.340	-0.337	-0.318	-0.335	-0.336	-0.338	-0.333
S_7	-0.328	-0.337	-0.346	-0.333	-0.328	-0.334	-0.332
S_8	-0.314	-0.343	-0.334	-0.335	-0.336	-0.340	-0.336
S_9	-0.340	-0.329	-0.334	-0.338	-0.338	-0.327	-0.329
S_{10}	-0.314	-0.337	-0.345	-0.333	-0.331	-0.350	-0.342
S_{11}	-0.340	-0.329	-0.334	-0.338	-0.333	-0.330	-0.325
S_{12}	-0.340	-0.337	-0.318	-0.335	-0.336	-0.338	-0.340
S_{13}	-0.340	-0.337	-0.346	-0.333	-0.328	-0.334	-0.345
S_{14}	-0.314	-0.343	-0.334	-0.335	-0.336	-0.340	-0.332
S_{15}	-0.340	-0.321	-0.334	-0.333	-0.338	-0.327	-0.329
S_{16}	-0.314	-0.337	-0.345	-0.333	-0.331	-0.350	-0.329
S_{17}	-0.340	-0.329	-0.318	-0.338	-0.333	-0.330	-0.347
S_{18}	-0.340	-0.321	-0.318	-0.335	-0.336	-0.338	-0.325
S_{19}	-0.328	-0.337	-0.334	-0.338	-0.350	-0.334	-0.333
S_{20}	-0.340	-0.337	-0.334	-0.335	-0.336	-0.327	-0.342

Table 3 summarizes the weighted coefficients of different performance indexes obtained using the entropy method, with or without considering the criterion. Besides, Table 4 presented an increasing order according to the general ranking, depicting the student. Further analysis showed that the final ranking of the students seems S2, S10, and S13 are the best three performances in the class.

Table 3. Positive and negative ideal solutions

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
V_j^+	2.228	2.233	2.227	2.236	2.234	2.229	2.232
V_j^-	-1.228	-1.233	-1.227	-1.236	-1.234	-1.229	-1.232

Table 4. The final ranking of the students

	C_i	Ranking		C_i	Ranking
S_1	0.557	**5**	S_{11}	0.430	**17**
S_2	0.610	**1**	S_{12}	0.511	**8**
S_3	0.471	**14**	S_{13}	0.600	**3**
S_4	0.477	**13**	S_{14}	0.494	**11**
S_5	0.375	**20**	S_{15}	0.420	**18**
S_6	0.485	**12**	S_{16}	0.563	**4**
S_7	0.505	**10**	S_{17}	0.467	**15**
S_8	0.510	**9**	S_{18}	0.413	**19**
S_9	0.448	**16**	S_{19}	0.555	**6**
S_{10}	0.609	**2**	S_{20}	0.519	**7**

IV. Conclusion

A conclusion in this article, the application of multiple criteria decision approach for the evaluation of student's performance discussed. The results obtained from the two methods of the analysis of TOPSIS and Entropy are a reliable technique to prioritize the alternatives regarding their proximity to the ideal solution in such a way that the selected alternative must have the shortest distance from the ideal solution and the longest distance from the dysfunctional solution. Meanwhile, the bases of these methods are different, the differences in the final results of the evaluation justified. Teacher and students' performance had a more critical role in Education.

The student's performance ranking is a strategic concern and has significant impacts on the efficiency of education management. Several alternatives must be considered and evaluated regarding many different conflicting criteria in an education management problem, leading to a broad set of subjective or ambiguous data from the result. Therefore, an adequate evaluation approach is essential to improve decision quality. This study, presenting a scientific framework to assess education management in school to get more information about student performance. Although the model was developed and tested for use in students performance, it can also be used with slight modifications in other decision-making problems in education management. Also, mathematical models combined with the proposed model. It will improve the proposed method and is one of the directions in future research.

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