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EVALUATION OF RESEARCH PROJECTS OF UNDERGRADUATE STUDENTS IN AN ENGINEERING DEPARTMENT USING TOPSIS METHOD

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Abstract: Evaluation of research projects of undergraduate students in an effective manner is important to rewarding student success in technical education at Engineering Departments. Research project of undergraduate students evaluation is mainly concerned with evaluating a number of research projects and then to grade them for rewarding. For this purpose, in this paper, an effective method for evaluating and to grade research projects of undergraduate students is proposed. A Multiple-Criteria Decision Making (MCDM) methodology to evaluate the research projects is suggested. Firstly, the criteria that will be used in the evaluation are determined and then those criteria are weighted in terms of their importance. In order to determine the degree of importance of each research projects the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method is used.

Keywords: Technical education, evaluation of research projects, MCDM, ranking projects, TOPSIS

Introduction

Research project evaluation and scoring of undergraduate students is a common and significant task for technical education in Engineering Departments. Its main objective is to clearly determine successful projects for rewarding with high points. Research project evaluation involves multiple evaluation criteria. In addition, some qualitative assessment criteria need to be taken into account. In the literature, numerous methods and techniques have been developed to research project evaluation and selection, such as; peer review process (Jayasinghe et al. 2006, Juznic et al. 2010), fuzzy logic (Coffin and Taylor 1996, Wang and Hwang 2007), fuzzy analytic hierarchy process (Hsu et al. 2003, Huang et al. 2008), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) (Mahmoodzadeh et al. 2007, Khalili-Damghani et al. 2013), data envelopment analysis (Linton et al. 2002). However, there is no study dealing with research project evaluation and scoring of undergraduate students in the literature. In order to deal with research project evaluation and scoring, the paper presents a method for evaluating and scoring research projects by using TOPSIS. Due to the multi-criteria nature for evaluating research projects, an analytical model integrated with AHP (Analytical Hierarchy Process) and TOPSIS is used to determine the right scoring of research projects. This paper proposes an integrated AHP-TOPSIS model considering only qualitative factors. In this concept, AHP is used to determine the criteria weights, and TOPSIS is used to calculate the alternatives ratings. The remainder of the paper is organized as follows. The second section gives the methods used in the paper to research projects scoring. The next section, an illustrative example is given, and conclusions are given in the last section.

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Proposed Multi-Criteria Decision-Making Method

AHP

AHP is a multi-attribute decision making method that was proposed in the 1970s by Saaty. It has been used extensively for analyzing and structuring complex decision problems (Hanine et al. 2016). The AHP method can be used to assist decision-makers to calculate the weight for each criterion by using pair-wise comparison judgments. In the paper, the process of AHP method consists of the following steps:

Step 1: Structure the decision hierarchy and determine the criteria.

Step 2: Establish the comparison matrix by using the fundamental scale (1:equal importance-9:absolute importance) of pair-wise comparison.

Step 3: Determine the relative importance of criteria.

Step 4: Verify the consistency of judgments across the Consistency Index ($CI = \frac{\lambda - n}{n-1}$, where λ is the Eigen value corresponding to the matrix of pair-wise comparisons and n is the number of criteria being compared) and the Consistency Ratio ($CR = \frac{CI}{RI}$, where RI is a random consistency index). A value of CR less than 0.10 is acceptable; otherwise the pair-wise comparisons should be revised.

TOPSIS

TOPSIS method was developed by Hwang, and Yoon (1981), for solving multiple criteria decision making problems based upon the concept that the chosen alternative should have the shortest distance to the positive ideal solution (A^+) and the longest distance from the negative ideal solution (A^-). For instance, the positive ideal solution maximizes the functionality and minimizes the cost, whereas the negative ideal solution maximizes the cost and minimizes the functionality (Hanine et al. 2016). The steps of TOPSIS model used in the paper are as follows:

Step 1: Establish a decision matrix (A) for the ranking, where m is the number of alternatives and n is the number of criteria.

$$A_{ij} = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \cdots & a_{mn} \end{bmatrix}$$

Step 2: Establish the standardized decision matrix (R) by using the following equation.

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}} \quad i = 1,2,\ldots,m; j = 1,2,\ldots,n$$

$$R_{ij} = \begin{bmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{bmatrix}$$

Step 3: Calculate the weighted normalized decision matrix (V) by multiplying the normalized decision matrix with its associated weights.

$$V_{ij} = \begin{bmatrix} w_1 r_{11} & \cdots & w_n r_{1n} \\ \vdots & \ddots & \vdots \\ w_1 r_{m1} & \cdots & w_n r_{mn} \end{bmatrix}$$

Step 4: Identify the positive ideal solution (A^+) and negative ideal solution (A^-).

$$A^+ = \left\{ \left(\max_i v_{ij} \middle| j \epsilon J \right), \left(\min_i v_{ij} \middle| j \epsilon J' \right) \right\} = \{v_1^+, v_2^+, \ldots, v_n^+\}$$

$$A^- = \left\{ \left(\min_i v_{ij} \middle| j \epsilon J \right), \left(\max_i v_{ij} \middle| j \epsilon J' \right) \right\} = \{v_1^-, v_2^-, \ldots, v_n^-\}$$

Step 5: Determine the Euclidean distance of each alternative from the positive and negative ideal solutions.

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

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

Step 6: Calculate the relative closeness coefficient of the *i*th alternative to ideal solution using the following equation:

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^+} \quad i = 1,2,\dots,m$$

Step 7: Rank all alternatives based on decreasing values of C_i^* and selecting the optimal one.

Numerical Illustration

In this section, in order to better explanation of the proposed method, an illustrative example is presented. The evaluation and scoring of research projects of students is very important in terms of rewarding success. The success or failure of research project depends on the various criteria, such as: C1: Scientific value and potential for application, C2: Academic or industrial novelty, C3: Research content and its appropriateness, C4: Rationality and feasibility. The proposed methodology is applied step by step to solve the research project evaluation problem. Five research projects are considered: RP1, RP2, RP3, RP4 and RP5. Decision-makers follow the computational procedure of criteria weights using AHP, and then rank the alternatives with TOPSIS. In the first step of AHP, a hierarchy model based on the criteria and alternatives given in Figure 1 is developed. The next step is dedicated to obtain the weights of criteria. A pair-wise comparison matrix of all criteria is realized. The preferences of decision-makers are identified using 1-9 scale. The initial pair-wise comparison matrix for the criteria provided by decision makers, the calculated criteria weights with AHP and *CR* are given in Table 1. It can be seen that the *CR* is less than 0.10.

The calculated weights of each criterion by using AHP are used as the input in TOPSIS. And also, using the 1-9 scale, the decision-makers are asked to evaluate the research projects. The decision matrix is given in Table 2. In the second step in TOPSIS technique, the decision matrix is normalized and the third step the weighted normalized decision matrix is established. It is given in Table 3. In Table 3, the positive and negative ideal solutions for the five research projects are also given. The ranking of research projects are calculated. Table 4 shows the evaluation results and final scoring of research projects.

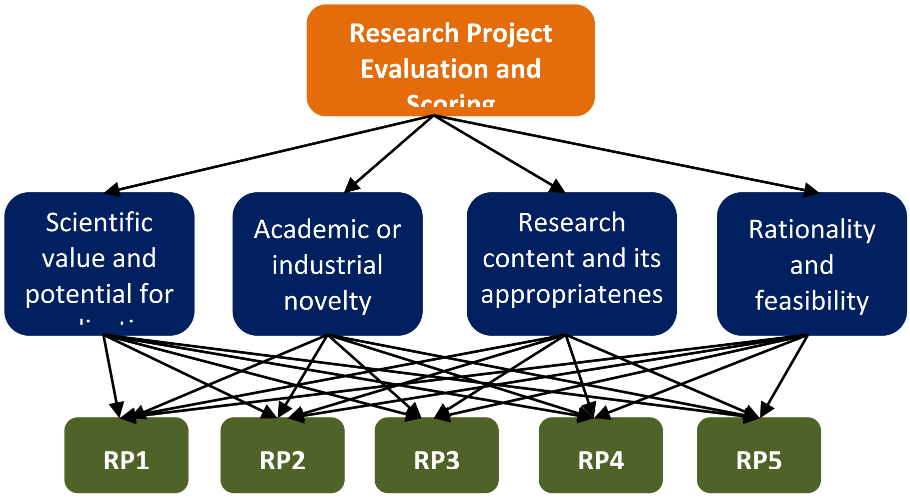

Figure 1. Hierarchy model of research project evaluation

Table 1. The comparison matrix of criteria and criteria weights

Criteria no	**C1**	**C2**	**C3**	**C4**	**Weights**
C1	1.00	2.00	3.00	2.00	0.41
C2	0.50	1.00	2.00	3.00	0.29
C3	0.33	0.50	1.00	2.00	0.17
C4	0.50	0.33	0.50	1.00	0.13
				CR	0.08

Table 2. The decision matrix

	C1	**C2**	**C3**	**C4**
Weights	0.41	0.29	0.17	0.13
RP1	6.00	8.00	3.00	5.00
RP2	7.00	5.00	9.00	3.00
RP3	5.00	8.00	8.00	4.00
RP4	5.00	2.00	7.00	4.00
RP5	3.00	4.00	8.00	7.00

Table 3. The weighted normalized decision matrix

	C1	**C2**	**C3**	**C4**
RP1	0.21	0.18	0.03	0.06
RP2	0.25	0.11	0.09	0.04
RP3	0.18	0.18	0.08	0.05
RP4	0.18	0.04	0.07	0.05
RP5	0.11	0.09	0.08	0.08
A^+	0.25	0.18	0.09	0.08
A^-	0.11	0.04	0.03	0.04

Table 4. The final evaluation and scoring of research projects

	S_i^+	S_i^-	C_i^*	**Score**
RP1	0.08	0.17	0.69	((0.69/0.69)100=) 100
RP2	0.08	0.17	0.67	((0.67/0.69)100=) 97
RP3	0.08	0.16	0.67	((0.67/0.69)100=) 97
RP4	0.16	0.08	0.35	((0.35/0.69)100=) 50
RP5	0.17	0.08	0.34	((0.34/0.69)100=) 49

Conclusion

Evaluating and scoring of research projects of undergraduate students in technical education at Engineering Departments is one of the most important issues for rewarding success. In this paper, a hybrid multi-criteria decision making process based on AHP and TOPSIS methods was proposed. The proposed methodology is tested by a numerical example and it was found that it functions satisfactorily.

References

Coffin, M.A., & Taylor, B.W, (1996). Multiple criteria R&D project selection and scheduling using fuzzy logic. *Computers & Operations Research*, *23*(3), 207–220.

Hanine, M., Boutkhoum, O., Tikniouine, A., & Agouti, T. (2016). Application of an integrated multi-criteria decision making AHP-TOPSIS methodology for ETL software selection. *SpringerPlus*, *5*, 263.

Hsu, Y.G., Tzeng, G.H., & Shyu, J.Z. (2003). Fuzzy multiple criteria selection of government-sponsored frontier technology R&D projects. *R&D Management*, *33*(5), 539–551.

Huang, C.C., Chu, P.Y., & Chiang, Y.H. (2008). A fuzzy AHP application in government-sponsored R&D project selection. *Omega*, *36*(6), 1038–1052.

Hwang, C.L., & Yoon, K., (1981). *Multiple attribute decision making: methods and applications*. In Springer, Heidelberg ISO/IEC 9126-1 (2001) Software Engineering-Product Quality—Part 1: Quality Model, International Organization for Standardization.

Jayasinghe, U.W., Marsh, H.W., & Bond, N. (2006). A new reader trial approach to peer review in funding research grants: An Australian experiment. *Scientometrics*, *69*(3), 591–606.

Juznic, P., Peclin, S., Zaucer, M., Mandelj, T., Pusnik, M., & Demsar, F. (2010). Scientometric indicators: Peer-review, bibliometric methods and conflict of interests. *Scientometrics*, *85*(2), 429–441.

Khalili-Damghani, K., Sadi-Nezhad, S., & Tavana, M. (2013). Solving multi-period project selection problems with fuzzy goal programming based on TOPSIS and a fuzzy preference relation. *Information Sciences*, *252*, 42–61.

Linton, J.D., Walsh, S.T., & Morabito, J. (2002). Analysis, ranking and selection of R&D projects in a portfolio. *R&D Management*, *32*(2), 139–148.

Mahmoodzadeh, S., Shahrabi, J., Pariazar, M., & Zaeri, M.S. (2007). Project selection by using fuzzy AHP and TOPSIS technique. *World Academy of Science, Engineering and Technology*, *30*, 333–338.

Wang, J., & Hwang, W.L. (2007). A fuzzy set approach for R&D portfolio selection using a real options valuation model. *Omega*, *35*(3), 247–257.