Evaluation Model for Choosing the Best Summer Work Based on Topsis

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Abstract: Summer vacation is a free time for high school students. Many high school students take summer jobs during the summer vacation to supplement their vacation time and earn some pocket money. The problem we face, however, is that we need to choose the most suitable summer job from a variety of options. Mathematical modeling can help us solve this problem.in this paper, we developed an evaluation model based on TOPSIS to solve the problem of choosing the best summer job. Although our model has some problems such as large computation, it is accurate and reliable. We expect more students to use our model to choose their summer jobs.

1. Introduction

1.1 Background

As high school students, we have a long summer vacation every year. In order to make the most of this summer holiday, many high school students will do summer jobs. However, not all summer jobs are suitable, so we need to develop a reasonable model to choose the best summer jobs.

1.2 Problem Analysis

This is a typical Multi-attribute Decision-making Problem [1-3]. Such problems need to evaluate alternative schemes according to determined attributes and indicators, and then select the best scheme [4]. Specifically, we will solve this problem in the following four steps:

1)Determine what factors influence us to choose the best summer job. This is the primary issue. At the same time, we should consider how to reasonably define and measure these factors. We will analyze and select the 5 most critical factors in Section 3;

2)The next step is to establish an evaluation model for the problem. We will establish a model based on Technique of Order Preference Similarity to the Ideal Solution (TOPSIS) method [5-8] in Section 4 to evaluate the quality of alternative summer job options;

3)The third part is to test our model. We will create 10 fictional high school students in Section 5, and use our model to choose the most suitable summer job for them according to their needs;

4)Finally, we will describe show our model. We will design a webpage in Section 6. High school students can use this webpage to choose the best summer job of them.

2. Factors and How to Measure Them

Our task now is to accurately describe these factors in mathematical language. We will give them appropriate units. The specific descriptions are as follows:

Hourly rates: We use the amount written on the summer job recruitment notice to calculate the hourly rate, such as $10 per hour. Through this simple method, this factor is quantitatively measured. The unit is USD per hour.

Daily working hours: The number of hours we use for job is used to quantitatively measure the factor of daily working hours. The unit is of course the hour.

Working days: Like the above, we use the number of working days written on the summer job recruitment notice to quantitatively calculate this factor. The unit is days.

Difficulty of job: Difficulty cannot be divided directly and quantitatively, but we can qualitatively divide the difficulty into five levels of 1-5: simple, relatively simple, medium, relatively difficult and difficult.

Distance to work: You can know how far the work place is from home through the map. We use miles as a unit to measure this factor and working from home is obviously zero miles.

Table 1 Factors

Factors	Unit and Description	Value
Hourly rates	USD per hour	
Daily working hours	hours	
Working days	days	
Difficulty of job	difficulty levels of 1-5	
Distance to work	miles	

3. Modeling Based on Topsis Method

3.1 What is Topsis?

According to Wikipedia, Technique of Order Preference Similarity to the Ideal Solution (TOPSIS) method [5-8] was first proposed by C.L.Wang and K.oon in 1981. It is a ranking method based on the similarity between a limited number of evaluation objects and an idealized goal, and it evaluates the relative merits of existing objects. TOPSIS method is a sorting method that approximates the ideal solution, which only requires that each utility function is monotonically increasing (or decreasing) [9]. TOPSIS method is a common and effective method in multi-objective decision analysis, also known as the pros and cons solution distance method [10].

The basic principle is to sort the evaluation object by detecting the distance between the evaluation object and the optimal solution and the worst solution [11]. If the evaluation object is the closest to the optimal solution and the furthest away from the worst solution, it is the best. Otherwise it's not optimal. Among them, each index value of the optimal solution achieves the optimal value of each evaluation index. Each index value of the worst solution reaches the worst value of each evaluation index [12-15].

3.2 Developing an Evaluation Model Based on Topsis Method

3.2.1 The Steps of Our Modeling Process

In order to build an evaluation model based on the TOPSIS method, we need the following steps:

Step 1: Design a form to get the required information. This step is for high school students to give us about their own preferences. We need to know three questions from the table: 1. What do they think is the importance of each factor? 2.Their idea of the perfect summer job; 3. What jobs they turn down.

Step 2: Determine an evaluation strategy. Based on the information already investigated in the first step, we designed an evaluation method based on the TOPSIS method. The methodology is based on two principles: 1. The closer the candidate is to their ideal summer job, the higher the score; 2. Which factor they think is more important, the greater the weight of that factor;

Step 3: Compare options for summer jobs. According to the assessment strategy determined in the second step, the score of candidate summer jobs is calculated separately. The option with the highest scores is the best summer job.

3.2.2 Designing a Form to Get the Required Information

We designed a form as shown below. Students were asked to fill in how much importance about each factor. And they need to tell us what kind of summer job they expect most. They also need to tell us what kind of work they don't want to do.

Table 2 Information Form

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work
Importance	(1-9, 9 means you care very much about this factor, and 1 means you hardly care about it)				
Your Desired Job	USD per hour	hours	days	difficulty levels of 1-5	miles
Your Rejected Job	USD per hour	hours	days	difficulty levels of 1-5	miles

3.2.3 Determining an Evaluation Strategy

We got the required information from the table above. Now is the time to use them. First of all, we exclude jobs that are the same as or worse than those they don't want to do in the alternative summer jobs. Then we calculate the difference between each candidate job and the most desired job in these 5 factors. Meanwhile we calculate the difference between the most desired job and the job that you don't want to do in these 5 factors. The ratio of the two differences multiplied by the importance is the deducted score. The full score is calculated as 100 points, minus the deducted points, is the final score of this alternative summer job.
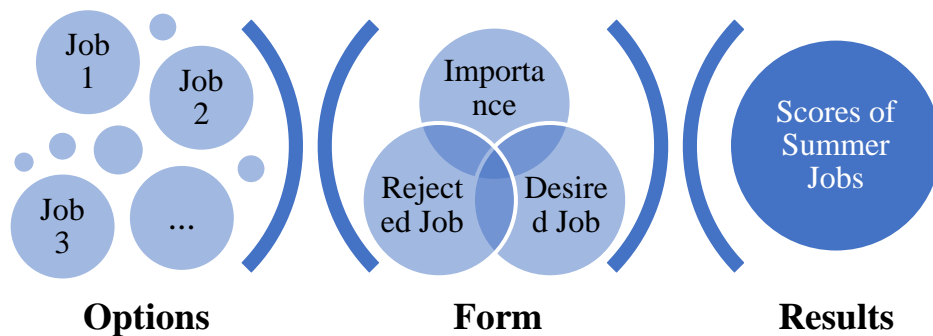

Fig.1 Determining an Evaluation Strategy

Specifically, suppose student A fills out the form as follows:

Table 3 Information Form Of Student a

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work
Importance	(1-9, 9 means you care very much about this factor, and 1 means you hardly care about it)				
	I_1	I_2	I_3	I_4	I_5
Your Desired Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	D_1	D_2	D_3	D_4	D_5
Your Rejected Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	R_1	R_2	R_3	R_4	R_5

There are three summer jobs for student A to choose from:

Table 4 Factors and Importance of Student a

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work
Job 1	USD per hour	hours	days	difficulty levels of 1-5	miles
	A_1	A_2	A_3	A_4	A_5
Job 2	USD per hour	hours	days	difficulty levels of 1-5	miles

	B_1	B_2	B_3	B_4	B_5
Job 3	USD per hour	hours	days	difficulty levels of 1-5	miles
	C_1	C_2	C_3	C_4	C_5

The scores for the three jobs are calculated according to the following formula:

$$S_1 = 100 - \left(\left| \frac{A_1 - D_1}{R_1 - D_1} \right| \times I_1 + \left| \frac{A_2 - D_2}{R_2 - D_2} \right| \times I_2 + \left| \frac{A_3 - D_3}{R_3 - D_3} \right| \times I_3 + \left| \frac{A_4 - D_4}{R_4 - D_4} \right| \times I_4 + \left| \frac{A_5 - D_5}{R_5 - D_5} \right| \times I_5 \right)$$

$$S_2 = 100 - \left(\left| \frac{B_1 - D_1}{R_1 - D_1} \right| \times I_1 + \left| \frac{B_2 - D_2}{R_2 - D_2} \right| \times I_2 + \left| \frac{B_3 - D_3}{R_3 - D_3} \right| \times I_3 + \left| \frac{B_4 - D_4}{R_4 - D_4} \right| \times I_4 + \left| \frac{B_5 - D_5}{R_5 - D_5} \right| \times I_5 \right)$$

$$S_3 = 100 - \left(\left| \frac{C_1 - D_1}{R_1 - D_1} \right| \times I_1 + \left| \frac{C_2 - D_2}{R_2 - D_2} \right| \times I_2 + \left| \frac{C_3 - D_3}{R_3 - D_3} \right| \times I_3 + \left| \frac{C_4 - D_4}{R_4 - D_4} \right| \times I_4 + \left| \frac{C_5 - D_5}{R_5 - D_5} \right| \times I_5 \right)$$

3.2.4 Compare Options for Summer Jobs

Not only do we need to consider scores, but we also need to get rid of alternative summer jobs that are the same or worse than the ones they don't want. In the case of Job 1, if any of these jobs meet the following conditions, it should be excluded:

$$A_1 \leq R_1$$
$$or \ A_2 \leq R_2 \ or \ A_2 > D_2$$
$$or \ A_3 \leq R_3 \ or \ A_3 > D_3$$
$$or \ A_4 \leq R_4 \ or \ A_4 > D_4$$
$$or \ A_5 \leq R_5 \ or \ A_5 > D_5$$

Finally, it can be found out which option is the best summer job by comparing scores of S_1, S_2 and S_3.

4. Test Our Model with Fictional Persons

4.1 Different Summer Jobs

To test our model, we assume that there are the following 5 kinds of summer jobs for students to choose from:

Table 5 Alternate Summer Jobs

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work
Job 1 Cleaner	USD per hour	hours	days	difficulty levels of 1-5	miles
	4	6	30	1	10
Job 2 Waiter	USD per hour	hours	days	difficulty levels of 1-5	miles
	7	7	25	2	2
Job 3 Lifeguard	USD per hour	hours	days	difficulty levels of 1-5	miles
	15	4	30	4	5
Job 4 Reporter	USD per hour	hours	days	difficulty levels of 1-5	miles
	9	6	15	3	30
Job 5 Tutor	USD per hour	hours	days	difficulty levels of 1-5	miles
	17	5	10	4	20

4.2 Test Our Model with Ten Fictional Persons

Ten fictional high school students are now choosing the best summer job for them. We asked them to fill out form 1 according to their preferences. And then we used our model to help them identify the best summer jobs.

Student A:

Table 6 Information Form Of Student a

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work
Importance	(1-9, 9 means you care very much about this factor, and 1 means you hardly care about it)				
	9	6	4	7	1
Your Desired Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	25	4	20	1	0
Your Rejected Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	5	8	40	5	15

Jobs 1, 4, and 5 were excluded because they were worse than the worst job students could accept. The remaining jobs were scored as follows:

$$S_2 = 84.52$$
$$S_3 = 87.92$$

So for student A, the best summer job is job 3, Lifeguard.

Student B:

Table 7 Information Form Of Student B

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work
Importance	(1-9, 9 means you care very much about this factor, and 1 means you hardly care about it)				
	3	6	2	6	9
Your Desired Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	30	6	15	1	0
Your Rejected Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	3	9	30	4	40

Jobs 1, 3, and 5 were excluded because they were worse than the worst job students could accept. The remaining jobs were scored as follows:

$$S_2 = 91.66$$
$$S_4 = 86.52$$

So for student B, the best summer job is job 2, Waiter.

Student C:

Table 8 Information Form Of Student C

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work
Importance	(1-9, 9 means you care very much about this factor, and 1 means you hardly care about it)				
	4	7	1	5	6
Your Desired Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	25	3	10	1	0
Your Rejected Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	2	6	35	5	30

Jobs 1, 2, and 4 were excluded because they were worse than the worst job students could accept. The remaining jobs were scored as follows:

$$S_3 = 90.38$$
$$S_5 = 86.19$$

So for student C, the best summer job is job 3, Lifeguard.

Student D:

Table 9 Information Form Of Student d

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work

Importance	(1-9, 9 means you care very much about this factor, and 1 means you hardly care about it)				
	7	2	7	7	2
Your Desired Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	30	1	10	2	0
Your Rejected Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	4	7	40	5	55

Jobs 1 and 2 were excluded because they were worse than the worst job students could accept. The remaining jobs were scored as follows:

$$S_3 = 85.45$$
$$S_4 = 88.09$$
$$S_5 = 89.77$$

So for student D, the best summer job is job 5, Tutor.

Student E:

Table 10 Information Form of Student e

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work
Importance	(1-9, 9 means you care very much about this factor, and 1 means you hardly care about it)				
	8	2	8	5	2
Your Desired Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	35	3	20	1	0
Your Rejected Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	5	8	50	5	60

Jobs 1, 4, and 5 were excluded because they were worse than the worst job students could accept. The remaining jobs were scored as follows:

$$S_2 = 88.28$$
$$S_3 = 87.68$$

So for student E, the best summer job is job 2, Waiter.

Student F:

Table 11 Information Form of Student f

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work
Importance	(1-9, 9 means you care very much about this factor, and 1 means you hardly care about it)				
	6	2	8	4	6
Your Desired Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	10	4	25	1	0
Your Rejected Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	1	8	35	4	30

Jobs 3, 4, and 5 were excluded because they were worse than the worst job students could accept. The remaining jobs were scored as follows:

$$S_1 = 89.00$$
$$S_2 = 94.77$$

So for student F, the best summer job is job 2, Waiter.

Student G:

Table 12 Information Form of Student g

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work
Importance	(1-9, 9 means you care very much about this factor, and 1 means you hardly care about it)				
	5	8	6	5	1

	USD per hour	hours	days	difficulty levels of 1-5	miles
Your Desired Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	25	4	10	1	5
Your Rejected Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	2	9	50	5	60

Jobs 2 was excluded because it was worse than the worst job students could accept. The remaining jobs were scored as follows:

$$S_1 = 89.14$$
$$S_3 = 91.08$$
$$S_4 = 89.62$$
$$S_5 = 92.64$$

So for student G, the best summer job is job 5, Tutor.

Student H:

Table 13 Information Form of Student h

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work
Importance	(1-9, 9 means you care very much about this factor, and 1 means you hardly care about it)				
	8	7	5	6	3
Your Desired Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	30	2	5	1	0
Your Rejected Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	3	9	50	4	55

Jobs 3 and 5 were excluded because they were worse than the worst job students could accept. The remaining jobs were scored as follows:

$$S_1 = 84.97$$
$$S_2 = 83.85$$
$$S_4 = 83.03$$

So for student H, the best summer job is job 1, Cleaner.

Student I:

Table 14 Information Form of Student I

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work
Importance	(1-9, 9 means you care very much about this factor, and 1 means you hardly care about it)				
	4	2	6	7	1
Your Desired Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	10	4	25	1	0
Your Rejected Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	1	8	35	4	30

Jobs 3, 4, and 5 were excluded because they were worse than the worst job students could accept. The remaining jobs were scored as follows:

$$S_1 = 93.00$$
$$S_2 = 94.77$$

So for student I, the best summer job is job 2, Waiter.

Student J:

Table 15 Information Form of Student J

Factors	Hourly rates	Daily working hours	Working days	Difficulty of job	Distance to work
Importance	(1-9, 9 means you care very much about this factor, and 1 means you hardly care about it)				
	7	8	2	3	6

Your Desired Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	25	4	10	1	5
Your Rejected Job	USD per hour	hours	days	difficulty levels of 1-5	miles
	2	9	50	5	60

Jobs 2 was excluded because it was worse than the worst job students could accept. The remaining jobs were scored as follows:

$$S_1 = 88.86$$
$$S_3 = 93.71$$
$$S_4 = 87.45$$
$$S_5 = 92.08$$

So for student J, the best summer job is job 3, Lifeguard.

5. Webpage to Describe and Use Our Model

To describe and use our model, we design a webpage, which can help us choose summer job. The webpage contains the following two parts:

Form Part. This part is mainly used to fill out the form so that we can get the user's preference for summer jobs.

Fig.2 Form Part.

Result Part. This part is used to return results telling the user which summer job is best for him or her:

Fig.3 Result Part.

6. Advantages and Disadvantages of Our Model

6.1 Advantages

1)The input part of our model is very simple. The user only needs to fill in a form through which we can get all the information we need.

2)Our model is very adaptable and robust. After testing, it is proved that the model can be applied to different high school students.

3)Our model is easy to program. Only basic programming skills are required to complete the code for the model.

6.2 Disadvantages

1)Our model is not sensitive enough. We need distinct differences in alternative summer jobs options;

2)The calculation part of our model is a little complicated and requires a lot of calculation.

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