Summer Work App Design Based on Analytic Hierarchy Process

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Abstract: Summer jobs are now an important topic these days, as now working experience is highly required in a long-term job application, and summer jobs have a large variety. It is more and more important to find a summer job that is good enough for you, and have a reasonable salary within a certain number of working hours. So, based on the common survey on some work field about summer jobs, we will give multiple objective choices for applicants to select, and we evaluate the preferences of the applicants then give jobs that have a high qualification to fit the applicants' preferences. In order to do that, first, we did a survey about what factors may affect the satisfaction of a summer job, we used the model analytic hierarchy process to handle the database of the following factors in the common work field of summer jobs. Our model has two main advantages. First, the model of analytic hierarchy process can calculate more complex issues that the traditional mathematic method can't process, in this circumstance, the choices of summer jobs. We can simplify the question into smaller factors with their own weight for people, by combining the weight of each factor, we can calculate what the best summer job people could have is. Another advantage is in the analytic hierarchy process we are able to separate the qualitative factors from the quantitative factors, but also can calculate them as a whole. The analytic hierarchy process able us to combine elements in different levels and have multiple results for different elements.

1. Introduction

We all knew how bad it is to have a really unpleasant summer job. Whether you have a low paid for hard work, or you are doing a job you don't really interested in, or maybe, you have great paid and do reasonable works in jobs that you like, but it just takes you way too much time to get to work from home. But how exactly can people find the "best" summer job, that is also the question that has been bothering ourselves for the past two weeks. It is not an easy task for us, to determine what is a great job and what is not, we need to focus on the factors that may affect the satisfaction for people, like the paid, the operating hour, and more [1].

We know that everyone wants a job with huge paid and needs small effort, but how to choose the "best" job that is reasonable to have. There is no perfect job, only the best job people can find, we need to consider jobs that maybe less satisficing as people wanted, but how much less satisficing, how to quantize those factors is also a question for us. We used the analytic hierarchy process to calculate the proportion of the factor that may affect the quality of a job for people. We surveyed factors that might affect people's evaluation toward different jobs, and we use the method of analytic hierarchy process [2].2 Assumption and Definition

2. Evaluation Based on Analytic Hierarchy Process

2.1 Principle of Analytic Hierarchy Process

Step1: we should develop a hierarchical structure with a goal at the top level, the attributes/ criteria at the second level and the alternatives at the third level as shown in the figure below:

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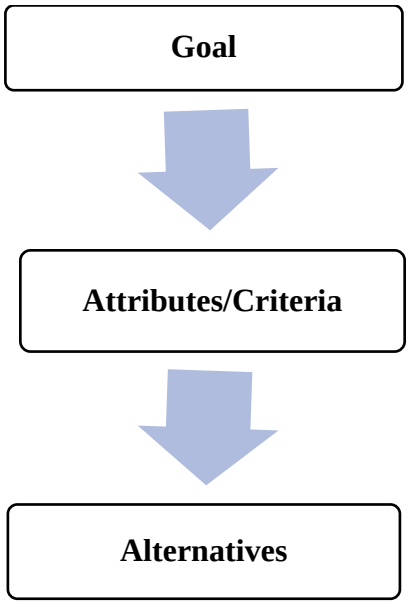

Fig.1 Hierarchical Structure

Goal: represent the aim of figuring out the issue, which means the analytic hierarchy process will achieve the goal (usually only one)

Attributes/Criteria: represent the taches of methods such as taking actions, policies, and schemes to achieve the destination layer.

Alternatives: represent the actions, policies, and schemes that we are going to use. Usually, there are several options to be chosen.

What we have to focus on is that each element belongs and only belongs to one layer; each element is only predominated by its relatively upper element, but not every element has a connection with its lower element. Even though there is no clear limitation on the number of elements in the criterion layer, under normal conditions, each layer is supposed to have less than nine elements. The reason why is that psychological researches show that only the amount of a group of stuff is less than nine, people can make an explicit judgment towards things' properties [3-7]. However, if the amount is more than nine, a decision-maker will get a relatively big logical error as he or she is judging the significance between every two of them. Therefore, we can reduce the element amount in the same layer by increasing the amount of layer.

Step2: building and making paired comparison matrixes. Pairwise comparison is made between the elements of the lower layer which are dominated by any element of the upper layer. Get the judgment matrix, and then find the weight d of each element. The measure of the importance is given by a 1-9 scale of relative importance. As showing below:

Table 1 Scale of Relative Importance

Scale	Meaning
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Intermediate value
Reciprocal	If the ratio of the importance of element i to that of element j is p_{ij}, then the ratio of the importance of element j to that of element i is $p_{ij} = 1/p_{ji}$

Let each element $C_1, C_2, \dots, C_n$ the importance of pairwise comparison of the target O, $a_{ij} = c_i/c_j$, $A = (a_{ij})_{n*n}, a_{ij} > 0$, $a_{ji} = 1/a_{ij}$ then get the comparison matrix:

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{mi} & \cdots & a_{mn} \end{bmatrix}$$

Step3: Hierarchical ordering and consistency checking

For judging matrix, A, using w represents a nonzero vector, and the calculation satisfies:$Aw = nw,$ which means eigenvalues and eigenvectors of $(p - ln)w = 0$. From $a_{ik} = a_{ij} \times a_{jk}$, we can get the rank A the matrix is 1, so there A only one nonzero eigenvalue. The sum of the eigenvalues of the A, that is, the sum of the principal diagonal elements of the A, is n, obtained as the only nonzero eigenvalue of the A, and the relationship between the eigenvalues is:

$$\lambda_i = 0, \lambda_{max} = n, (\lambda_i \neq \lambda_{max})$$

Because only the judgment matrix A completely consistent, $\lambda_{max} = n$ can meet the criteria. So, we test the consistency of the judgment matrix. CI as a consistency indicator, CI=0, there is complete consistency; CI close to 0, there is satisfactory consistency, the greater the CI, the more serious the inconsistency. But only with the value of CI consistency test standard of judging matrix A is inaccurate. Therefore, the introduction of average random consistency index RI test whether the pairwise comparison matrix A has satisfactory consistency.

Using CR as the consistency ratio of the judgment matrix, $CR = CI/CR$. When $CR < 0.1$, it is considered that the judgment matrix has satisfactory consistency; When $CR \geq 0.1$, the judgment matrix does not have basic satisfactory consistency. If the matrix A does not have satisfactory consistency, the judgment matrix needs to be modified, which means after w is calculated as the eigenvector, The values of $w_i/w_j(i, j = 1,2, \dots, n)$ are sorted according to the position of the j column in the i line, and the new judgment matrix is compared with the corresponding position of the original judgment matrix. The largest absolute value of the difference is the data to be modified [8].

Step4: Hierarchical General Ranking and Consistency Testing

The weight vector of a set of elements to an element in its upper layer has been obtained. We need to calculate from the highest level to the lowest level, if the total ranking weight of m elements in a layer is $a_1, a_2, \dots, a_m$. There are n elements in the lower B layer, and their weight relative to the hierarchy is $b_{ij}, \dots, b_{nj}$(when B_i and A_j have no connection, $b_{ij} = 0$) So the weight of each element in the B layer to the decision target is obtained, that is, the total ranking weight of each element in the B layer b_i is:

$$b_i = \sum_{j=1}^{m} b_{ij} a_j, (i = 1,2, \dots, n)$$

A single ranking consistency index is obtained from the previous step$CI(j), (j = 1, \dots, m)$The corresponding average random consistency index RI_j, so the random consistency ratio of the total ranking of the B layer is:

$$CR = \frac{\sum_{j=1}^{m} CI(j) a_j}{\sum_{j=1}^{m} RI(j) a_j}$$

When $CR < 0.1$, it is considered that the total ranking results of hierarchy have satisfactory consistency and accept the analysis results.

2.2 Evaluation of Each Factor

We build a hierarchical model based on existing information, as shown in the following figure [9].

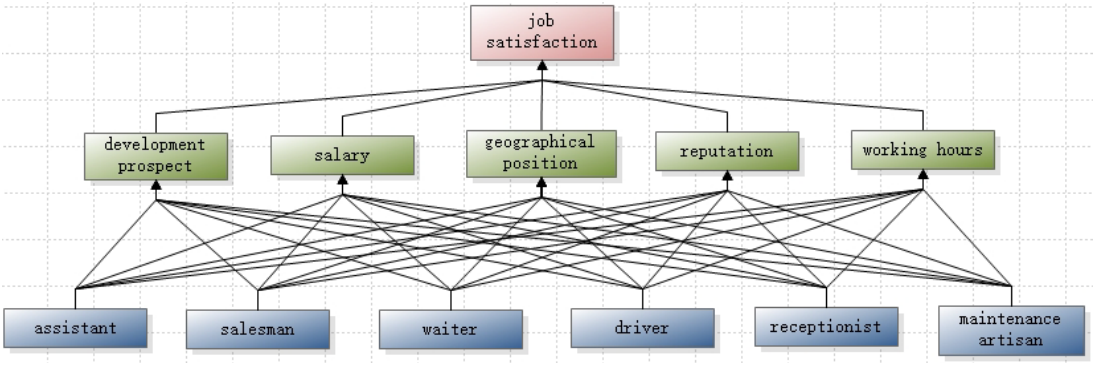

Fig.2 A Hierarchy Model Based on Existing Information

3. Design for the App

3.1 Explanation of Choosing the Fittest Job System

In part 5, our evaluation algorithm considers the individual ranking requirements of a part-time job for different high school students because of their different preferences.

To this end, we design an app to help high-school students to choose the most suitable job according to their preferences. Students only need to fill in a related preference, then we can personalize the job according to the things they fill.

Considering that different high school students consider different factors, for example, some students want to earn more money and buy things they want, while others may care about the working position. These are the questions we asked.

Write down the score you think about working hours, development prospect, reputation, salary, geographic position, these five factors in number? (The total scores of 5 factors must be 10)

If the passenger chooses 2 on working hours, 3 on salary, 1 on position, 2 on reputation, and 1 on development prospect. The best suitable job may have a good salary and good reputation and fewer working hours. We will find the job has nearly weight to 20% on working hours, 30% on salary, 10% on position, 20% on reputation, and 10% on development prospect [10, 11].

This is the evaluation model:

$$\bar{x} = \frac{x_1 f_1 + x_2 f_2 + x_3 f_3 + \cdots + x_k f_k}{\sum_1^k f_i}$$

Where x is the weight students choose and f is the weight of the job. $\bar{x}$ is the score of each job for each student.

According to the results, a suitable job for each student can be realized. We can give them the job had the biggest $\bar{x}$ for them as the most suitable job for them.

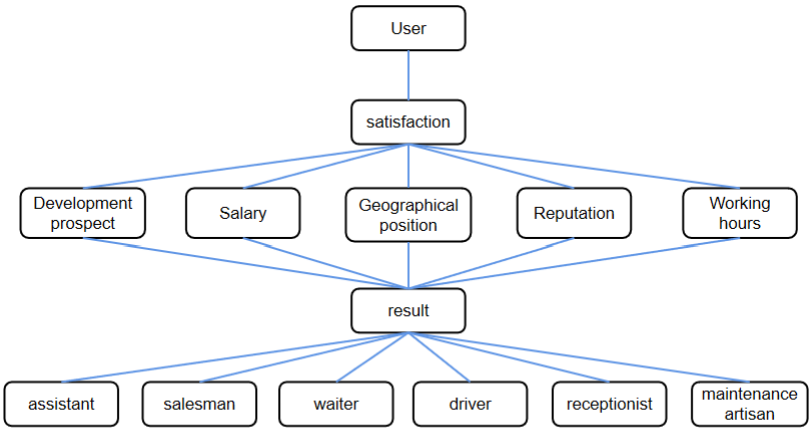

Fig.3 Option Design

3.2 Ui Design of the App

We use a free UI designing web to create a simple UI design, as shown below in Figure 6.

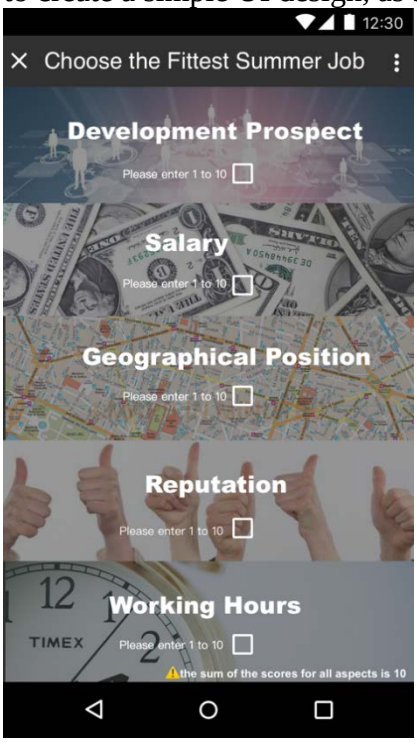

Fig.4 Graphs of Ui Design

Note: all the graphs come from internet search

These six examples show how will the app generate the job based on personal preference those five factors.

4. Sensitivity Analysis

Table 2 Data of A Suspect (Used Before)

	developm...	salary	geograph...	reputation	working h...
development prospect		1	1	1	1
salary			1	1	1
geographical position				1	1
reputation					1
working hours					

Fig.5 The Relative Hierarchical Total Sort

Table 3 the Matrix With Original Weight

	assistant	salesman	waiter	driver	receptioni...	maintena...
assistant		1	2	2	1	2/1.6
salesman			2	2	1	2/1.6
waiter				1	1/2	1/1.6
driver					1/2	1/1.6
receptionist						2/1.6
maintenance artisan						

To test the sensitivity of our model we use the data of a suspect we used before which is in Table 13 and the result that is processed by our model, which is in Figure 16. And have the original weight of each factors as in the Table 14.

Table 4 the Matrix With New Weight

	assistant	salesman	waiter	driver	receptioni...	maintena...
assistant		4	2	2	1	2/1.6
salesman			2	2	1	2/1.6
waiter				1	1/2	1/1.6
driver					1/2	1/1.6
receptionist						2/1.6
maintenance artisan						

Fig.6 The New Result

To compare we changed the data of the factor of development prospective, and the new weight of the factors and the new result of each job are shown below in Table 15 and Figure 17. And according to the result, we can tell even though we change very slightly in only one factor, but it displays importantly in the result, and the weight, it proved that our model is quite sensitive and have strong reliability.

5. Advantages and Disadvantages of Our Model

5.1 Advantages

When the traditional mathematical methods cannot figure out the complex practical issue, the analytic hierarchy process can judge steps of the relative significance of each element to our brain. Only remaining every factor that affects students' choice of job is retained and then calculated as a simple weight. Thus, dealing with the problems.

When the issue is unable to deal with a certain degree of the tendency, we chose to use the analytic hierarchy process (AHP) to quantify the effects of students part-time various kinds of factors (degree of each factor's influence on the results of each level), through the way of data processing, salary, working hours, commuting time and part-time job categories in determining students interaction [13]. Then, elaborating on the different types of various factors. At the same time, combined with the value judgment of the influence of each factor in the team, qualitative analysis was conducted on the basis of quantitative analysis. The problem which is difficult to be quantified and has multiple criteria is quantified into a multi-level single target problem. After determining the quantitative relationship between elements of the same level and elements of the next level by comparing them in pairs, a simple mathematical operation is carried out at last to get a simple and clear result.

5.2 Disadvantages

Although we have found a good way to assign a value to each of these factors and quantify them, it is too subjective. The construction of the model and the input of judgment matrix are all the subjective judgments from us, which often lead to mistakes due to the decision our careless consideration and caring for one thing and losing another, as we cannot guarantee the weight of each factor can represent everyone's opinion.

Also, the analytic hierarchy process fails to provide a new scheme, as it can only select the superior from the alternatives. If we do not come up with a new and proper way to evaluate summer job options, it will cause us to choose the best among the many schemes we have found out.

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