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Application of analytic hierarchy process in traffic choice of college students' tourism

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Abstract: *With the development of society, college students travel more and more commonly. In the travel process, the choice of transportation tool is an important step. In this paper, analytic hierarchy process (AHP) is used to solve the problem of vehicle selection for college students, which provide a method for the choice of transportation.*

Keywords: *AHP; traffic choice; college students' tourism*

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I. Introduction

With the continuous improvement of people's life, college students travel has become the norm. The choice of means of transportation is an important step in tourism.

The analytic hierarchy process (AHP) is a systematic and hierarchical analysis method combining qualitative and quantitative analysis. Its principle is that a complex problem is decomposed into a number of factors, the factors make up a class hierarchy according to the dominated relationship, through analysis and comparison, the total order of relative importance of the decision scheme is set, which provide quantitative basis for controlling things development. The analytic hierarchy process is widely used in many fields[1-4]. The analytic hierarchy process is also widely used in vehicle selection. For example, Wu et al.[5] used the analytic hierarchy process to study the application to the choice of means of transportation. Li[6] studied the application of analytic hierarchy process in vehicle selection.

In this paper, we make college students as the research object, use analytic hierarchy process to study the choice of means of transportation in the process of tourism.

II. Models

With the gradual increase of people's consumption level in recent years, the proportion of tourism is increasing. As an independent group, college students have abundant time and a certain curiosity, which lays the foundation for their journey. During the travel process, the choice of transportation tool is an important step. Next, we use analytic hierarchy process to build a model, and study the choice of transportation tool of the travel process.

Analytic hierarchy process is a practical multi-scheme or multi-objective decision-making method that can effectively deal with decision-making problems proposed by American operations research scientist Professor T.L.Saaty in 1973. The basic principle of analytic hierarchy process is as follows, according to the laws of the people's thinking, in the face of complex selection problem, the problem is decomposed into the component factors, then according to these factors will govern formation are grouped recursively class structure, through comparing the two way to determine the relative importance of various factors in the hierarchy, and then integrated decision makers judgment, determine the relative importance of total decision scheme.

The steps of the analytic hierarchy process are as follows:
(1) Establish a multi-level progressive structural model for the various elements that constitute the decision-making problem;
(2) Compare the elements of the same level (level) with the elements of the higher level as criteria, determine their relative importance according to the evaluation scale, and establish a judgment matrix accordingly;
(3) Determine the relative importance of each element through calculation;
(4) Through the calculation of comprehensive importance, the pros and cons of various programs are ranked, so as to provide decision-makers with a basis for scientific decision-making.

The tree hierarchical structure diagram is constructed in the figure 1, the structure diagram is divided into three layers and the highest level is the target layer (O): Choose the right transportation; the middle layer is the criterion layer (B) : it is the factor that the college student considers during choosing the right transportation, namely safety, fast, convenience, economic(thrifty) and comfortable; The bottom layer is the scheme layer (D) : plain(P_1), train(P_2), ship(P_3) and bus(P_4).

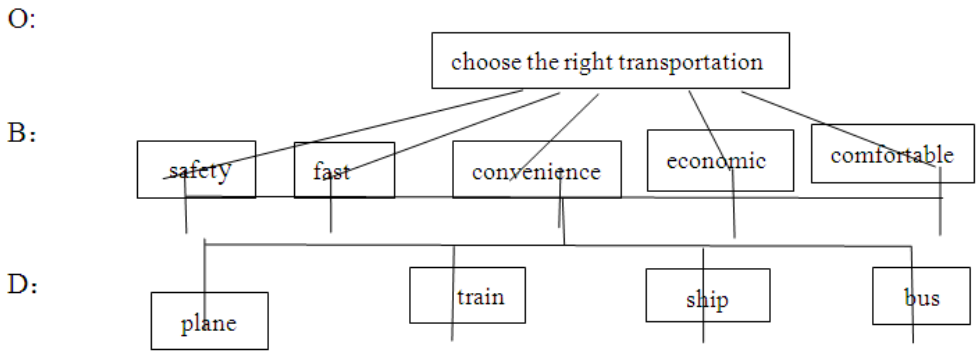

Figure1 The tree hierarchical structure diagram

According to the criterion layer of figure 1, the influence degree of various factors on the target layer is different. In order to prevent the difficult comparison of different factors, in this paper, the relative scale scale[7] is used for comparison as shown in table 1.

Table 1 Relative scale scale

Scale values b_{ik}	Meaning
1	Impact of between B_i and B_k is same
3	Impact of B_i is a little bit important than B_k
5	Impact of B_i is obviously important than B_k
7	Impact of B_i is much more important than B_k
9	Impact of B_i is extremely important than B_k
2,4,6,8	Impact of B_i and B_k is between the above adjacent levels.
1,1/3,...,1/9	Impact ratio of B_k and B_i is the reciprocal of b_{ik} of the above

The matrix composed of the elements $b_{ik}\,(i,k=1,2,\cdots,\ n)$ is called $B=(b_{ik})_{n\times n}$, which is called the comparison matrix. During the selection of the right transportation, the following matrix B is obtained through the collection and integration of the choice of college students' transportation tools through questionnaire survey, interview and online data access, etc. The matrix is as follows:

$$B = \begin{pmatrix} 1 & 1 & 1 & 2 & 3 \\ 1 & 1 & 5 & 5 & 3 \\ 1 & 1/5 & 1 & 3 & 2 \\ 1/2 & 1/5 & 1/3 & 1 & 1 \\ 1/3 & 1/3 & 1/2 & 1 & 1 \end{pmatrix}$$

Similarly, we compare the importance of each index in the criterion layer, and get the judgment matrix as follows.

$$B_1 = \begin{pmatrix} 1 & 5 & 1 & 2 \\ 1/5 & 1 & 5 & 5/2 \\ 1 & 1/5 & 1 & 1/2 \\ 1/2 & 2/5 & 2 & 1 \end{pmatrix}, B_2 = \begin{pmatrix} 1 & 4/3 & 4/3 & 4 \\ 3/4 & 1 & 1 & 3 \\ 3/4 & 1 & 1 & 3 \\ 1/4 & 3 & 3 & 1 \end{pmatrix}, B_3 = \begin{pmatrix} 1 & 2/7 & 1 & 2 \\ 7/2 & 1 & 7/2 & 7 \\ 1 & 2/7 & 1 & 2 \\ 1/2 & 1/7 & 1/2 & 1 \end{pmatrix},$$

$$B_4 = \begin{pmatrix} 1 & 1/7 & 1 & 1/5 \\ 7 & 1 & 7 & 7/5 \\ 1 & 1/7 & 1 & 1/5 \\ 5 & 5/7 & 5 & 1 \end{pmatrix}, B_5 = \begin{pmatrix} 1 & 5/3 & 1 & 5 \\ 3/5 & 1 & 3/5 & 3 \\ 1 & 5/3 & 1 & 5 \\ 1/5 & 1/3 & 1/5 & 1 \end{pmatrix},$$

The matrices formed by pairwise comparison are all positive mutual matrices, and the positive mutual matrices are uniform matrices. However, in the actual construction matrix, due to the artificial subjective comparison, the judgment matrix obtained may not conform to the consistent matrix, so there should be a range of inconsistency, even if it is within the allowable range, so it is necessary to carry out the consistency test to B .

For the paired comparison matrix B that are inconsistent (but within the allowable range), the eigenvector corresponding to the maximum eigenroot is used as the weight vector w , and the weight vector w is used as the eigenvector of B , to find the maximum eigenroot $\lambda_{\max}$.

The consistency index is

$$CI = \frac{\lambda_{\max} - 1}{n - 1}.$$

To measure the size of CI , Santy introduced a random consistency index RI . The random consistency index is related to the order of the judgment matrix. The larger the order of the matrix is, the greater the possibility of the random deviation of consistency is. The corresponding relationship is in table 2.

Table 2. Relationship between RI and the order of the judgment matrix

order	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Considering that the deviation of consistency may be caused by random reasons, it is necessary to compare CI with random consistency indexes RI when testing whether the judgment matrix has satisfactory consistency as follows.

$$CR = \frac{CI}{RI}$$

When $CR < 0.1$, the judgment matrix is considered to pass the consistency test; otherwise, the consistency is not satisfied and the matrix needs to be adjusted.

Thus, the composite weight W of the five elements of the criterion layer relative to the target can be calculated as follows.

$$W = \begin{bmatrix} 0.238 \\ 0.416 \\ 0.174 \\ 0.082 \\ 0.090 \end{bmatrix}.$$

The maximum eigenvalue of the judgment matrix B is $\lambda_{\max} = 5.293$, the consistency index is

$$CI = \frac{\lambda_{\max} - n}{n-1} = 0.0728 \ ,$$

Because $n = 5$, from table 2, we get $RI = 1.12$ and

$$CR = \frac{CI}{RI} = \frac{0.0728}{1.12} = 0.065 < 0.1,$$

So B passes the consistency test and w can be used as the weight vector.

Then the weight of the five elements in the scheme layer relative to the criterion layer can be calculated as follows:

$$u_1 = [0.4393 \ ; 0.2766 \ ; 0.1375 \ ; 0.1466 \ ]^T,$$
$$u_2 = [0.2969 \ ; 0.2227 \ ; 0.2227 \ ; 0.2577 \ ]^T,$$
$$u_3 = [0.1667 \ ; 0.5833 \ ; 0.1667 \ ; 0.0833 \ ]^T,$$
$$u_4 = [0.0714 \ ; 0.5000 \ ; 0.0714 \ ; 0.3571 \ ]^T,$$
$$u_5 = [0.3571 \ ; 0.2143 \ ; 0.3571 \ ; 0.0714 \ ]^T,$$

Then 4×5 order matrix is follows

$$U = \begin{bmatrix} 0.4393 & 0.2969 & 0.1667 & 0.0714 & 0.3571 \\ 0.2766 & 0.2227 & 0.5833 & 0.5000 & 0.2143 \\ 0.1375 & 0.2227 & 0.1667 & 0.0714 & 0.3571 \\ 0.1466 & 0.2577 & 0.0833 & 0.3571 & 0.0714 \end{bmatrix},$$

$W \times U$ is calculated as the composite weight vector of the scheme layer relative to the target layer is as follows.

$$W \cdot U = \begin{bmatrix} 0.238 \\ 0.416 \\ 0.174 \\ 0.082 \\ 0.090 \end{bmatrix} \begin{bmatrix} 0.4393 & 0.2969 & 0.1667 & 0.0714 & 0.3571 \\ 0.2766 & 0.2227 & 0.5833 & 0.5000 & 0.2143 \\ 0.1375 & 0.2227 & 0.1667 & 0.0714 & 0.3571 \\ 0.1466 & 0.2577 & 0.0833 & 0.3571 & 0.0714 \end{bmatrix}$$

$$= [0.2952 \quad 0.3201 \quad 0.1924 \quad 0.1922]$$

Therefore, the weight of plain as the target layer is 0.2952, the weight of train is 0.3201, the weight of ship is 0.1924, the weight of bus is 0.1922. the bigger the weight, the scheme is more consistent with the target, that is, the train is the most most appropriate and favorite travel vehicle for college students.

The results show that train is the most appropriate transportation choice for college students, which is safe and affordable. And the train is more convenient, students in all regions have conditions to take; At the same time, the environment and comfort of train is better than that of buses and other means of transportation, which is consistent with the results of the questionnaire students' choice of convenience, speed and low price. Because they are students with limited economic ability, they pay more attention to the problem of money when choosing transportation tools and traveling, which is consistent with the results of the questionnaire

III. Conclusions

In this paper, we analyze the choice problem of the traffic tool of college students' tourism by building the hierarchical analysis model, which play a guiding role to choose the traffic tools for college students.

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