Selection of Transportation Mode of Materials for Petroleum Engineering Projects in Central Asia Based on AHP-SVM

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ABSTRACT
With the rapid development of China's economy, the need for overseas energy has been increasing year by year. Under the background of "One Belt And One Road", China's investment in the oil development of central Asian countries has been increasing, the export of petroleum engineering project materials has been increasing, and the freight volume has been soaring. For the central Asian multinational petroleum logistics mode of transportation, from the quality assurance, the transportation price, transportation efficiency, cooperation, service consciousness, etc. have different dimensions to consider options, in order to improve the operation efficiency, under the principle of comprehensive multi-factor conditions, using the analytic hierarchy process ((AHP) to a variety of analysis and comparison are made on the evaluation scheme, supplemented by support vector machine (SVM) method to evaluate, and to determine the best transportation options, achieve the objectives of the operation efficiency.

Keywords: *Analytic hierarchy process, Support vector machines, Choice of mode of transport.*

1. INTRODUCTION

With the further development of "One Belt And One Road", the logistics of central Asia petroleum engineering project becomes more active, and the transnational transportation develops in a diversified way [1]. And in the choice of way, often will encounter more complex, the problem of multiple factors, need a lot of factors as evaluation criteria, such as the quality of the transport security, cooperation, service consciousness and efficiency of transportation price, transportation, etc., through the qualitative analysis can determine the more perfect, and the Analytic Hierarchy Process (AHP) is one good method.

In this paper, AHP is used to select the transportation mode with better comprehensive evaluation, and support vector machine is used to evaluate it, so as to determine the optimal transportation scheme.

2. PRINCIPLES OF THE RESEARCH

1.1. The Principle of AHP

AHP was put forward by the famous operational research experts T.L. Atti and Weber in the 1970s [2]. It is a qualitative and quantitative multi-objective decision analysis method, which can quantify the decision maker's experience judgment, and is widely used in the analysis and decision under the circumstance of complex target structure and lack of necessary data. Especially for some complicated problems which are difficult to be fully quantified, satisfactory results can be obtained.

AHP is based on the hierarchical structure of goals, objectives, constraints, department, etc to evaluation scheme, adopt the method of comparing two determine judgment matrix, and then the judgment matrix of the feature vector components of the maximum characteristic root as the corresponding coefficient,

finally it is concluded that the weight of each package. the relative importance function table and give the importance level of pair comparison, the reliability is high and the error is small. AHP, as a qualitative and quantitative tool, has been widely used in many fields.

1.2. Support Vector Machine Theory

Statistical learning theory is a machine learning method with solid theoretical foundation developed on the basis of traditional statistics. Since the 1990s, other learning methods such as neural network have encountered difficulties. it has formed a relatively perfect theoretical system-statistical learning theory, and put forward a new pattern recognition method-support vector machine, so this research has been paid more and more attention.

Support Vector Machines(SVM) is a new machine learning method proposed by V. Vapnik based on Statistical Learning Theory (referred to as SLT)[3-10]. It shows many unique advantages in solving the problems of small sample, nonlinear and high-dimensional pattern recognition, and can effectively realize the accurate fitting of high-dimensional nonlinear system based on small sample. Good results have been achieved in pattern recognition, function approximation and probability density estimation. The regression function can be expressed as follows:

$$y_i[(w \bullet x_i)+b]-1 \geq 0 \quad i=1,...,n \tag{1}$$

In this case, the classification interval is equal to $2/\|w\|$, so that the maximum interval is equivalent to the minimum. The classification surface that satisfies the condition and minimizes is called the optimal classification surface, and the training sample point on H1 and H2 is called support vector. By using the Lagrange optimization method, the above optimal classification surface problem can be transformed into its dual problem, the maximum values of the following functions can be solved.

$$Q(\alpha)=\sum_{i=1}^{n}\alpha_i-\frac{1}{2}\sum_{i,j=1}^{n}\alpha_i\alpha_j y_i y_j (x_i \bullet x_j) \tag{2}$$

For the Lagrange multiplier corresponding to each sample, the corresponding sample is the support vector, and the optimal classification function is obtained.

$$f(x)=\operatorname{sgn}\{(w^* \bullet x)+b^*\}=\operatorname{sgn}\left\{\sum_{i=1}^{n}\alpha_i^* y_i (x_i \bullet x_j)+b^*\right\} \tag{3}$$

Because this method allows the evaluator to compare

For the nonlinear problem, it can be transformed into a linear problem in a high-dimensional space by nonlinear transformation, and then the optimal classification plane in the space can be transformed. Select the appropriate kernel function to meet the Mercer condition to transform into a high-dimensional space, and the objective function is transformed into:

$$Q(\alpha)=\sum_{i=1}^{n}\alpha_i-\frac{1}{2}\sum_{i,j=1}^{n}\alpha_i\alpha_j y_i y_j K(x_i,x_j) \tag{4}$$

The corresponding classification function becomes:

$$f(x)=\operatorname{sgn}\{(w^* \bullet x)+b^*\}=\operatorname{sgn}\left\{\sum_{i=1}^{n}\alpha_i^* y_i K(x_i,x_j)+b^*\right\} \tag{5}$$

The kernel functions commonly used in support vector machines are as follows:

(1) Gaussian radial basis kernel function.

$$K(x_i,x_j)=\exp(-\gamma\|x_i-x_j\|^2) \tag{6}$$

(2) Polynomial kernel function.

$$K(x_i,x_j)=((x_i \bullet x_j)+1)^d \tag{7}$$

(3) Linear kernel function.

$$K(x_i,x_j)=(x_i \bullet x_j) \tag{8}$$

(4) one-dimensional Fourier kernel function.

$$K(x_i,x_j)=(1-q^2)/[2(1-2q\cos(x_i-x_j)+q^2)] \tag{9}$$

Among these four kinds of kernel functions, the radial basis kernel function is the most widely used, which has a wide convergence domain and is an ideal classification basis function. Gaussian radial basis kernel function is used in this study.

3. EMPIRICAL RESEARCH

3.1. Selection of AHP

In this case, the data of trans-national transportation modes of logistics for central Asia petroleum engineering project undertaken by a company in December 2019 is selected, and the operational efficiency of 6 different transportation modes (China-europe freight train, Air freight, Full steam freight, China - Europe express, Transfer from Horgos to Railway, Comprehensive evaluation of the operation

efficiency of vehicle-to-railway from Horgos.) was evaluated comprehensively.

The construction of transport mode index system cannot completely rely on literature query. This study also adopts the method of combining literature analysis and expert group to construct the transport mode index system. Through the joint discussion of the expert group, the characteristic items of transportation mode were classified, deleted, merged and reconstructed, and the four most important evaluation indexes were finally obtained [11].

The AHP method is now applied to further evaluate the six modes of transport according to the measurement standards required by the objectives [12]. The

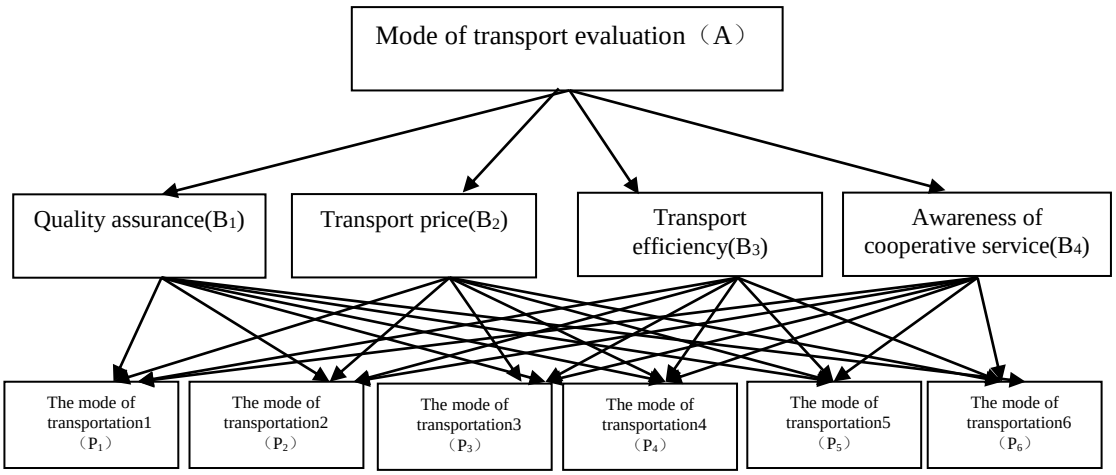

Figure 1 The hierarchical structure of transport mode evaluation

hierarchical structure of the evaluation of the modes of transport is shown in Figure 1.

In this way, a judgment matrix can be constructed by comparing the importance of the factors at each level with those at the previous level, and the judgment matrix of the importance of the sub-objective layer with respect to the total objective layer, the judgment matrix of the criterion layer with respect to the sub-objective layer and the judgment matrix of the scheme layer with respect to the criterion layer can be constructed in turn.

Delphi and other survey methods are used to survey managers and leaders. After summarizing and analyzing the survey results, the following judgment matrix can be obtained, and relevant consistency test results can be obtained through calculation, as shown in Table 1-5.

Table 1. Judgment Matrix A-B

A	B1	B2	B3	B4	W1
B1	1	1	3	3	0.375
B2		1	3	3	0.375
B3			1	1	0.125
B4				1	0.125

λ_{max} =4.000, CI=0.000, RI=0.900, CR=0.000<0.1, conformance test passed.

Table 2. Judgment Matrix B1-P

B1	P1	P2	P3	P4	P5	P6	W2
P1	1	2	3	4	5	7	0.405
P2		1	1	3	2	5	0.207
P3			1	1	3	2	0.148
P4				1	1	3	0.105
P5					1	3	0.090
P6						1	0.045

λ_{max} =6.234, CI=0.047, RI=1.240, CR=0.038<0.1, conformance test passed.

Table 3. Judgment Matrix B2-P

B1	P1	P2	P3	P4	P5	P6	W3
P1	1	3	4	2	7	5	0.402
P2		1	1	4	3	5	0.216
P3			1	1	4	3	0.157
P4				1	1	2	0.104
P5					1	2	0.070
P6						1	0.051

λ_{max} =6.422, CI=0.084, RI=1.240, CR=0.068<0.1, conformance test passed.

Table 4. Judgment Matrix B3-P

B1	P1	P2	P3	P4	P5	P6	W4
P1	1	4	3	3	6	4	0.413
P2		1	1	5	2	4	0.197
P3			1	1	3	2	0.150
P4				1	1	2	0.096
P5					1	3	0.088
P6						1	0.056

λ_{max} =6.508, CI=0.102, RI=1.240, CR=0.082<0.1, conformance test passed.

Table 5. Judgment Matrix B4-P

B1	P1	P2	P3	P4	P5	P6	W5
P1	1	3	5	3	5	7	0.425
P2		1	1	5	3	6	0.219
P3			1	1	5	3	0.149
P4				1	1	3	0.095
P5					1	3	0.073
P6						1	0.039

λ_{max} =6.524, CI=0.105, RI=1.240, CR=0.085<0.1, conformance test passed.

Calculated level weights of total sorts for W = (0.408, 0.211, 0.152, 0.102, 0.080, 0.048), the levels of total ordering consistency check for CI = 0.081, RI = 1.240, CR = 0.065 < 0.1, the consistency check through.

Therefore, through the investigation of comprehensive factors such as the quality assurance, transportation price, transportation efficiency and cooperative service consciousness of the transportation mode, it can be seen through calculation that P1=0.408 is the highest, and the corresponding transportation mode 1 is the preferred scheme, that is, the optimal transportation mode selection scheme.

In this study, 4 evaluation indexes of operational efficiency level of transportation modes obtained were taken as input indexes, respectively represented by A1-A4, as shown in Table 6.

Table 6. Evaluation Data and Grade

Sample	Serial Number	A1	A2	A3	A4	Class
Training Sample	1	0.4	0.7	0.5	0.3	high
	2	0.5	0.3	0.6	0.4	medium
	...					...
	50	0.6	0.7	0.5	0.3	low
Test Sample	1	0.4	0.2	0.5	0.5	high
	2	0.7	0.5	0.4	0.2	medium
	...					...
	50	0.1	0.4	0.2	0.5	low

Operational efficiency score value of the mode of transportation will be used as the output, and with high, medium and low three levels to measure, and through the study of the training sample, for each category of classification function, thus the new target is evaluated, can be used to input the score values of the four indexes, were assessed the level of the evaluation objects.

Sample Selection and Data Source 100 collected data were selected as training and test samples, and normalization processing was carried out first. During the training of the samples, 50 groups of samples of different grades (the last 50 groups in Table 6) were randomly selected as the test samples, and the other 50 groups of data (the first 50 groups in Table 6) were used as training samples.

In model training, Matlab7.0 language programming was adopted to realize SVM model training. Radial basis function (RBF) was selected as the kernel function of the model, and two parameters were determined: penalty parameters and kernel parameters. Cross-validation method was adopted for the selection of parameters. 50 training samples were used as the learning set for training. It was finally found that when parameter values were taken as penalty parameter C=1.1657 and kernel function K =0.6501 respectively, the error was the minimum, and then the SVM model was the optimal model [13].

After the SVM model training is completed, the untrained samples are used to verify the SVM model optimized by learning. After 50 group in table 6 for testing, test results, testing level and practical level self-agreement reached 91.1667%, SVM evaluation result more accord with the actual, and more accurate, more intuitive, more concise, more suitable for the mode of transportation operation efficiency level for examination and assessment, shows that using SVM to evaluate the operational efficiency of the mode of transportation level is feasible, verify the AHP concludes that the mode of transportation of 1 is the preferred solution, is the best way to transport options.

4. CONCIUSION

The combination of qualitative analysis and quantitative analysis is often an effective method to solve the objective world, while AHP focuses on qualitative analysis while SVM focuses on quantitative analysis. And quantitative analysis is often restricted by objective factors, in this case the evaluation mode of transportation of the SVM data collection restricted by many conditions, only according to the evaluation of existing data, often cannot achieve the desired purpose, this requires using qualitative analysis methods such as AHP method for, according to the corresponding evaluation standard to evaluate, in order to achieve the goal of eventually.

AUTHORS' CONTRIBUTIONS

In this paper, based on comprehensive multi-factors, the author uses analytic hierarchy process to analyze and compare various evaluation schemes, supplemented by support vector machine method for evaluation, and then determines the best choice scheme to achieve the goal of operational efficiency.

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