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Risk Analysis and Evaluation of Cross-Border Supply Chain of Overseas Engineering Projects Based on PEST-RS-SVM Driven by "Belt and Road" Trade

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Abstract. Driven by the "One Belt and One Road" trade, overseas engineering projects have become the embodiment of cooperation with countries along the "One Belt and One Road", thus bringing frequent material exchange of cross-border supply chains among countries. In order to achieve smooth and rapid development of cross-border supply chain, reduce risks and strengthen control, it is necessary to screen the risk factors of cross-border supply chain, establish a system and make correct and reasonable evaluation. In this paper, PEST method is adopted to analyze the risk factors of external cross-border supply chain of energy enterprises under the background of "One Belt and One Road", and corresponding evaluation index system is established. The risk evaluation model of external cross-border supply chain was established by combining the rough set theory and support vector mechanism, and the risk evaluation model of phoenix risk was used to comprehensively evaluate the risk of cross-border supply chain along the "Belt and Road", and corresponding countermeasures were put forward.

Keywords. One Belt and One Road; Cross-border supply chain; PEST-RS-SVM

1. Introduction

The Belt and Road Initiative refers to the joint efforts of many countries to build the Silk Road Economic Belt and the 21st Century Maritime Silk Road.

"One Belt and One Road" Initiative is a major innovation since the reform and opening up and even the founding of the People's Republic of China. Since the initiative was put forward, China's foreign trade has been greatly improved in both quantity and quality. The growth of foreign trade will inevitably bring about an increase in the demand for foreign trade services [1].

"Belt and Road" involves 66 countries in the world. These countries have huge differences in policies and laws, economy and culture, natural environment and geography, logistics and communication technology [2]. With the rapid development of trade, these countries have huge differences in policies and laws, economy and culture, natural environment, geography, culture and technology. The imperfect laws and regulations, imperfect management system, inadequate infrastructure, low clearance

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efficiency, high cost, poor timeliness, insufficient reliability, imperfect cross-border reverse logistics system, and shortage of management professionals in cross-border supply chain all bring hidden dangers to the security and stable development of cross-border supply chain. How to coordinate the relationship between the two is an important topic that needs in-depth study [3].

The development of cross-border supply chain is the driving force of "Belt and Road" countries to seek the maximization of interests in the pursuit of common development, and it has become the connection and link of the economic development of many countries [4]. "Extensive consultation" emphasizes equality, mutual respect, seeking common ground while shelving differences, consultation and cooperation, and accommodates the interests of all parties [5]. "Joint contribution" is an open and inclusive system of cooperation on a voluntary basis. "Sharing" is to achieve mutual benefit and win-win results, take fair, balanced and sustainable development as the purpose and goal, and build a community of common prosperity and security [6]. Therefore, with the common development of economic security and stability of China and the rest of the world, the cross-border supply chain needs to be completed and shared through extensive consultation [7]. In addition, it needs to form and clarify the rights, responsibilities and obligations of each country in the mechanism of security and development, and gradually enjoy the benefits brought by the security and development. Therefore, the cooperation of cross-border supply chain security and development is of great significance to the economic growth of China and countries along the "Belt and Road" [8].

2. Brief Introduction to the Construction Principle of Risk Analysis Evaluation Model

2.1. Principle of PEST

PEST analysis model is an analysis tool for enterprise macro environment, where P for politics, E for economics, S for society, T for technology. PEST analysis can be used to analyze the macro strength of an enterprise and its related factors, as shown in Figure 1.

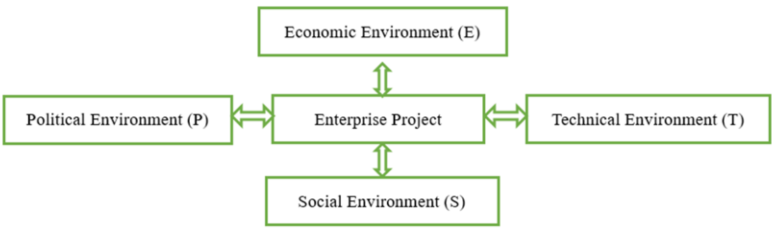

Figure. 1. PEST analysis model

In Figure 1, political environment (P) refers to the social system and institutional nature of the country where the enterprise is located. Economic environment (E) mainly consists of macro environment and micro environment. The macro environment reflects the state and level of national economic development, while the micro environment reflects the economic environment of the enterprise, such as the consumption and savings of local residents and the employment degree of the local population; Technological environment (T) mainly refers to the status and level of technological development in the place where the enterprise is located; Social environment (S) includes a country's residents' education level, customs, values, cultural level, etc., all of which directly or indirectly affect residents' recognition of enterprises [9].

2.2. Rough Set Theory

In 1982, Polish scientists first proposed Rough Set theory (RS), which is a new mathematical tool to deal with fuzzy and uncertain knowledge. Rough set theory can effectively analyze all kinds of incomplete information such as inaccuracy, inconsistency and incompleteness. It can also analyze and reason data to discover hidden knowledge and reveal potential laws and reasoning. The core of rough set theory is attribute reduction, that is, by calculating the dependence degree of decision attribute value on feature attribute, the index with zero importance degree is deleted, and the expressive ability of knowledge representation system is not affected. Rough set theory can effectively solve the problems of ambiguity and uncertainty in the evaluation, calculate the relative importance of indicators, and make the evaluation and strategy selection more reasonable [10]. Rough set theory can be understood by the following definitions:

If the prediction object is W and an equivalence relation on W is R, then k =(W,R) is called an approximate space.

If x,y ∈ W and x,y ∈ R, then x and y are uncontestable on k, and R is an indistinguishable relation.

If property set P ⊆ R and P indicates phi, so IP is P a indiscernibility relation, ind (P); If the attribute r∈P and ind(P)=ind(P-(r)), then r is omitted on P.

Then, the attribute r has little effect on the description of features and is a redundant attribute. The omitted attribute will not affect the description of attribute features [11].

2.3. Support Vector Machine Theory

Support vector Machine (SVM) theory is a new general learning method based on statistical learning theory. It can effectively realize the accurate fitting of high-dimensional nonlinear systems based on small samples, and adopt the principle of minimum structural risk, which has a good generalization [12]. Its regression function can be expressed as follows:

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

When Mercer's condition is met, the objective function is transformed into a high-dimensional space:

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

the corresponding classification function becomes:

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

Gaussian radial basis kernel function is the most widely used in support vector machine, has a wide convergence area and only contains one parameter, so this paper uses radial basis kernel function for calculation. By constructing Lagrange function, the dual of the original function is obtained. The above problem eventually becomes a convex quadratic programming problem [13]. These ideas and ways to solve the problem is also very useful in many different fields, such as the fault diagnosis of mechanical equipment, the information recognition in video, and the development of commercial market sales plans [14-17].

3. PEST Based Cross-Border Supply Chain Risk Analysis of Overseas Engineering Projects

An overseas engineering project of an energy engineering enterprise is selected as the research object, and the status quo of this enterprise project and the risk factors it may face in the external cross-border supply chain are studied by PEST analysis model. Combined with literature reading method and practical analysis method, the risk factors of overseas engineering project enterprises mainly include financial risk, market risk and financial risk under economic environment.

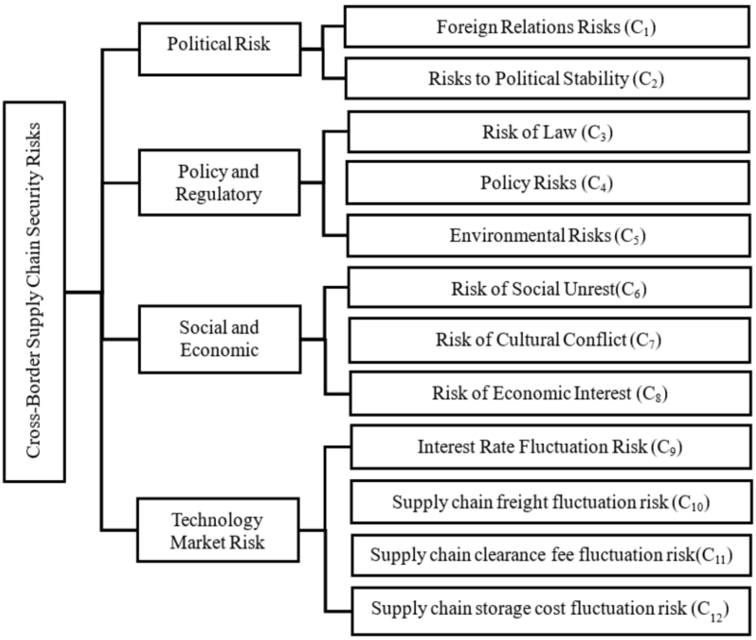

Figure. 2. PEST analysis model

Diplomatic relations in the political environment and political stability in the host country; Laws, policies and environmental protection in policies and regulations; Social unrest, cultural conflicts, and economic interests in the social economy; Interest rate fluctuation, supply chain freight fluctuation, supply chain clearance cost fluctuation, supply chain storage cost fluctuation under the technology market.

The evaluation index system of external cross-border supply chain should follow the three principles of systematic principle, scientific principle and comparability principle to ensure the construction of a scientific, reasonable, feasible and reliable risk evaluation system.

The evaluation index system of external cross-border supply chain designed this time is shown in Figure 2.

In the PEST analysis model in Fig.2, there are 4-criteria layer indexes and 12 indicator layer indexes, according to which the initial indicator set of evaluation can be established, as shown in Table 1.

Table 1. Initial index set of cross-border supply chain risk assessment

Target Layer	Layer of Criterion	Indicator Layer	Serial Number
Cross-Border Supply Chain Security Risks	Political Risk	Foreign Relations Risks	C_1
		Risks to Political Stability	C_2
	Policy and Regulatory Risks	Risk of Law	C_3
		Policy Risks	C_4
		Environmental Risks	C_5
	Social and Economic Risks	Risk of Social Unrest	C_6
		Risk of Cultural Conflict	C_7
		Risk of Economic Interest	C_8
	Technology Market Risk	Interest Rate Fluctuation Risk	C_9
		Supply chain freight fluctuation risk	C_{10}
		Supply chain clearance fee fluctuation risk	C_{11}
		Supply chain storage cost fluctuation risk	C_{12}

Table 2. Risk assessment grade standards

Level of Risk	Degree of Risk	Risk Grade Range
I	Very High	[1.0,0.8)
II	High	[0.8,0.6)
III	Medium	[0.6,0.4)
IV	Low	[0.4,0.2)
V	Very Low	[0.2,0.0)

By referring to the risk grade classification standard of construction projects and the risk safety grade classification of Wu Chukuo and Zhang Lei, the risk levels of cross-border supply chain are divided into I, II, II, IV and V levels from high to low according to the possibility of occurrence of risk events, risk loss and social impact.

This paper divides the risk criteria into five levels, as shown in Table 2.

4. Risk Assessment Model of Overseas Project Cross-Border Supply Chain Based on Rough Set and Support Vector Machine

4.1. Risk Assessment Model

(1) Evaluation data preparation

The above evaluation index set is taken as the conditional attribute in the decision table. $\{C_1,C_2 \ldots C_{12}\}$ indicates that the sample data is taken for attribute reduction processing, and then the sample classification is carried out.

(2) Rough set data reduction

The simple steps for the evaluation index intensification with the rough set calculation and analysis tool are as follows:

1) Establish a decision table for the research data according to the rough set theory.

The decision attributes of the decision table include: risk assessment level *{extremely high, high, medium, low, very low}* is a single decision attribute represented by {d}.

Set up the information system

$$S= \{U, R, V, f\}, U= \{X1, X2,\ldots Xn\},$$

$$R=C\cup D,C = \{C1, C2\ldots C12\}$$

and D {d} are conditional and decision attributes respectively.

2) Data preprocessing, including decision table data completion, decision table discretization.

3) Select the Algorithm for reduction and use Johnson's algorithm method.

(3) SVM for sample classification

After the rough set is used to reduce the attributes of the sample data of cross-border supply chain risk evaluation index, the core attributes of risk evaluation are retained, the calculation amount is reduced, and the calculation process is simplified. Then the evaluation index is classified according to the reduced core attributes.

1) Select kernel function and parameters. At present, there are three types of inner product kernel functions which are widely used. Generally, radial basis function is considered first when selecting kernel function, mainly because of its relatively few parameters and small numerical difference.

2) Sample training. The sample data were classified by SVM multi-classification method, and a 2-level support vector machine classifier was established to distinguish two evaluation levels ({extremely high, high, medium, low, very low}).

3) Sample test. After the sample training is completed, the test sample data is input into the trained 2-level support vector machine classifier. According to the output results, different sample evaluation levels can be distinguished.

4.2. Empirical Analysis

The evaluation index set is taken as the conditional attribute in the decision table.

$\{C_1,C_2 \ldots C_{12}\}$ indicates that the sample data is taken for attribute reduction processing, and then the sample classification is carried out.

The research period of this paper is 2018-2021, and the data are collected from China Statistical Yearbook.

(1) Sample data selection.

Data are used as learning samples, as shown in Table 4. C_1-C_{12} in the table are 12 evaluation indexes of cross-border supply chain risk respectively.

(2) *RS* reduction.

Johnson's Algorithm was used to reduce the attributes of the preprocessed decision table, and the reduction result was obtained by taking the intersection of the two.

(3) SVM classification.

Rosetta, a rough set calculation and analysis tool, was used to reduce the attributes of the sample data of evaluation indicators, and four core attributes were retained, so as to carry out multi-level classification of cross-border supply chain risks.

The risk coefficient sample set was divided into the training sample set and the test sample set, and the 9 groups of samples in Table 3 were randomly selected as the training sample set to construct the multi-layer SVM model. The remaining 3 groups of samples are used as test specimen sets to test the generalization ability of the model, as shown in Table 3, where the meanings of letters A-D are shown in Table 4.

Table 3. Sample data table of risk coefficient evaluation model

No.	A	B	C	D	E	F	G	H	I	J	K	L
1	0.13	0.11	0.12	0.23	0.23	0.12	0.12	0.25	0.23	0.23	0.22	0.22
2	0.24	0.14	0.21	0.22	0.17	0.21	0.21	0.21	0.22	0.17	0.19	0.19
3	0.23	0.17	0.15	0.19	0.25	0.15	0.15	0.19	0.19	0.25	0.23	0.24
4	0.12	0.21	0.22	0.15	0.23	0.22	0.22	0.22	0.24	0.21	0.12	0.23
5	0.21	0.15	0.16	0.22	0.32	0.16	0.32	0.25	0.23	0.23	0.21	0.12
6	0.15	0.22	0.24	0.19	0.21	0.23	0.19	0.23	0.12	0.22	0.15	0.21
7	0.22	0.19	0.12	0.23	0.15	0.12	0.23	0.12	0.21	0.19	0.22	0.15
8	0.16	0.23	0.21	0.17	0.22	0.21	0.17	0.21	0.15	0.23	0.16	0.22
9	0.24	0.17	0.22	0.25	0.36	0.25	0.27	0.15	0.32	0.17	0.24	0.16
10	0.18	0.25	0.19	0.21	0.24	0.22	0.21	0.33	0.16	0.25	0.12	0.24
11	0.21	0.14	0.23	0.12	0.22	0.16	0.15	0.26	0.23	0.21	0.31	0.23
12	0.18	0.16	0.23	0.12	0.22	0.15	0.22	0.23	0.22	0.25	0.15	0.22

The specific operation process is to write a program on the MATLABr2016a platform, use the LIBSVM toolbox, radial basis function as the kernel function, and use the RS object reduction of 9 groups of training sample data (Table 3) for sample training of the SVM model. After the training, the regression estimation method was used to carry out back judgment on the 9 groups of samples in Table 3, and the misjudgment rate of the back judgment was 0, indicating that the training results of the prediction model were highly correct and could be applied to actual engineering practice.

Table 4. The meanings of 12 letters A-L

A	Risk of diplomatic relations	G	Risk of cultural conflict
B	Political stability risk	H	Economic interest risk
C	Legal risk	I	Interest rate fluctuation risk
D	Policy risk	J	Freight fluctuation risk
E	Environmental risk	K	Risk of fluctuation of customs clearance fee
F	Social unrest risk	L	Risk of warehouse expense fluctuation

It can be seen that the combined prediction model based on RS-SVM established in this paper has high prediction accuracy and clear significance for cross-border supply chain risk prediction. As can be seen from the results, the risk situation of cross-border supply chain is relatively severe, still in grade II, in a high-risk state, the future cross-border supply chain risk is still facing many challenges.

The above results show that cross-border supply chain has been in a high-risk situation, it is necessary to take measures to prevent and deal with the occurrence of risks.

5. Conclusion

In this paper, PEST, rough set and support vector machine are combined, and mathematical tools Matlab and Rosetta are used for practical calculation and analysis of the model. The model has a high accuracy and can be well applied to cross-border supply chain risk assessment to obtain a more accurate prediction rate, which can play a role in security early warning. The risk evaluation index system can also be used as a reference to evaluate the quantitative basis of cross-border supply chain risk.

According to the evaluation results, in the evaluation period, the risk of cross-border supply chain is generally in the high-risk range. In addition, international political, social and economic risks continue to rise, which seriously restricts cross-border supply chains.

The development of "The Belt and Road" is closely related to the expansion of overseas projects. With the expansion of the scope of project development activities, the cross-border supply chain will extend to a wider range, and its security risks will also be affected by more comprehensive factors. In order to reduce risks and promote the stable development of "One Belt and One Road" initiative, this study analyzes the risk factors under the background of "One Belt and One Road" through PEST analysis method, establishes the corresponding risk evaluation index system, proposes the feasibility of the risk evaluation system and evaluation model, and carries out the evaluation. However, the applicability and validation of the risk rating model are insufficient, the selection of indicators is limited, and the relevant data is not universal and historical. Therefore, it is necessary to broaden the research horizon and depth in the future, and continue to deepen the relevant research in this field.

In the development of cross-border supply chain driven by the "Belt and Road" trade, there are many high-risk factors, and various measures should be taken to avoid and reduce the occurrence of risks:

First, from the government level, build a logistics information platform, improve the cross-border supply chain infrastructure, improve the efficiency of the supply chain from the hard link, and reduce the risks in the flow of materials;

Second, standardize the management of cross-border supply chain enterprises, improve the level and efficiency of customs clearance and clearance, accelerate the steady development of supply chain, and reduce the risk of differentiation between regulations and laws between countries;

Third, from the enterprise level, improve the level of professional technology, establish a standardized system, promote modern technology in all links of the supply chain, improve the efficiency of the supply chain with scientific and technological means, complete the work in the fastest time and speed, reduce risks;

Fourth, cross-border supply chain enterprises should actively connect with cross-border trade e-commerce service platform, accelerate the informatization of cross-border supply chain, and jointly build logistics informatization platform;

Fifth, strengthen the cooperation between cross-border e-commerce platform and more cross-border supply chain enterprises, extend the breadth and depth of supply chain, achieve scale efficiency, and resist the occurrence of high risks.

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