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ANALYSIS OF SUDAN'S OIL INDUSTRY INVESTMENT ENVIRONMENT BASED ON AHP AND DISSIPATIVE STRUCTURE THEORY

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ABSTRACT

Research on how to make Sudan's oil industry investment environment turn into the dissipative structure which suitable for China's investment after Sudan is split. First, use AHP to build universally applicable evaluation model for the country's oil resources investment environment. Thereby based on the evaluation index weight sorted by the model we identified several significant factors that impact the resources' country, such as oil grade, political stability, mining difficulty, access of oil industry, the possibility of military conflict and the economic development in oil resources country. Then according to the dissipative structures theory, combined with the actual situation in split Sudan and South Sudan we explore that in what political and diplomatic means to help local oil industry investment environment turn into the dissipative structure which suitable for China's investment.

KEYWORDS

Sudan, oil investment environment, evaluation model, dissipative structure.

1. INTRODUCTION

Chinese oil companies which had played an important role in major oil projects as operators and major shareholders worked closely with the original Sudan. After nearly 20 years painstaking efforts China has established one of the largest and most complete overseas oil industrial chain in original Sudan which include pipeline, oil refining, crude oil exploration and development, etc. However, there are lots of contradictions and armed conflicts in original Sudan due to various problems. In 2011, the original Sudan was split into two independent sovereign states. In the end of 2013, South Sudan erupted a fierce armed conflict resulted in some areas' oil production terminated. This series of problems have seriously affected the normal production of Chinese oil companies in Sudan.

Therefore, it is particularly important to study overseas oil industry investment environment evaluation model, establish and perfect a set of widely applicable, efficient and accurate investment environment evaluation model, and then discuss in which aspect to help local oil industry investment environment turn into the dissipative structure which suitable for China's investment in accordance with the model.

2. ESTABLISHMENT OF EVALUATION INDEX SYSTEM AND MODEL

2.1 Elements of the Investment Environment

The host country's investment environment is seen as a big system by the systems theory. Based on a study, the system consists of the following six elements, they are political environment, legal environment, economic environment, social and cultural environment, and service environment and natural environment [1].

(1) Political environment. In the constituent elements of the investment environment, political environment is primal factor. The host country's political environment is directly related to the safety of investments and the primary factor that should be considered by foreign investors. Political environment has features such as wide coverage, high-impact, hard to have a greater change in the short term, etc.

(2) Legal environment. In the constituent elements of the investment environment, the legal environment has an important position after the political environment as the "barometer" and the "anemoscope" of the investment environment. Whether it is the political environment, or the economic conditions, most of them can be shown in the form of law.

(3) Economic environment. In the constituent elements of the investment environment, the economic environment has the most direct impact and is the most fundamental factor of the international investment activities. Economic environment is the macroeconomic environment, the micro-economic environment and the economic policy of the host country.

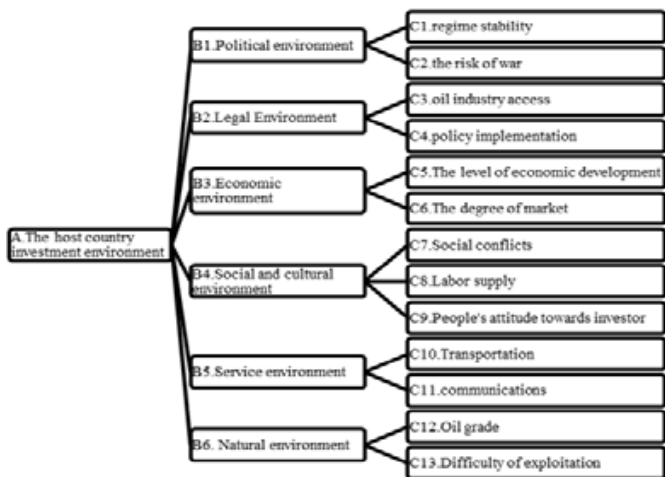
(4) Social and cultural environment. In the constituent elements of the investment environment, social and cultural environment is a kind of soft environment which is difficult to have a direct or simply impact in a short period to the foreign investors. But in the long run, it will have an indirect, potential and broad impact on foreign investors.

(5) Service environment. Service environment is a direct investment environment faced by foreign investors which directly affects the efficiency and quality of foreign investment.

(6) Natural environment. Natural environment of a country is determined by its resources endowment and certain geographical location which has extremely rigid that difficult to change through human effort. It is an important factor affecting the economic development of a country so that it will directly or indirectly affect foreign investment and production activities. Specific investment environment evaluation influential factors are shown in Table 1.

Table 1: Foreign direct investment environment system.

Primary indicators	Secondary indicators
Political environment	political system, regime stability, policy continuity, the risk of war



Legal environment	completeness of the legal system, fairness of the legal, stability of the legal
Economic environment	macroeconomic and microeconomic environment, economic policy
Social and cultures	social environment, cultural environment
Service environment	Infrastructure, public services
Natural environment	natural conditions, natural resources

2.2 Establishment of the Evaluation Index System

Overseas oil industry investment environment not only involves both specific countries and regions, but also associates with the related oil industry. Therefore, it is a combination of both the regional investment environment and the industrial investment environment. According to the investment environment level, regional investment environment

belongs to the macro environment for investment and industry investment environment are micro investment environment. So, Petroleum investment environmental assessment involves many factors and indicators. Study showed comprehensive evaluation model will form a lot of irrational and uncertainty in different contexts [2]. Therefore, to establish a comprehensive, strong usability for a wide range of evaluation index system is very important.

In this paper, based on the principal of establishment of the elements system of AHP and the factors involved in the investment environment theory, we selected the following six aspects of thirteen segments index shown in the Figure 1. At the same time, we take into account the specific circumstances and characteristics of the host country's oil resources.

Figure 1: Petroleum investment environment evaluation index system.

2.3 Construct Judgment Matrix

According to AHP application steps, first, we can establish the judgment matrix for criteria layer and programs layer. Then according to 1-9 scale expert scoring method, we have matrix constructed as follows.

$$\begin{matrix}
 & B_1 & B_2 & B_3 & B_4 & B_5 & B_6 \\
 B_1 & 1 & 3 & 3 & 7 & 5 & 1/3 \\
 B_2 & 1/3 & 1 & 3 & 5 & 3 & 1/3 \\
 B_3 & 1/3 & 1/3 & 1 & 2 & 2 & 1/4 \\
 B_4 & 1/7 & 1/5 & 1/2 & 1 & 1/5 & 1/9 \\
 B_5 & 1/5 & 1/3 & 1/2 & 5 & 1 & 1/4 \\
 B_6 & 3 & 3 & 4 & 9 & 4 & 1
 \end{matrix}$$

$$\begin{matrix}
 & C_1 & C_2 \\
 C_1 & 1 & 3 \\
 C_2 & 1/3 & 1
 \end{matrix}
 \begin{matrix}
 & C_3 & C_4 \\
 C_3 & 1 & 4 \\
 C_4 & 1/4 & 1
 \end{matrix}
 \begin{matrix}
 & C_5 & C_6 \\
 C_5 & 1 & 3 \\
 C_6 & 1/3 & 1
 \end{matrix}$$

$$\begin{matrix}
 & C_7 & C_8 & C_9 \\
 C_7 & 1 & 3 & 1/3 \\
 C_8 & 1/3 & 1 & 1/6 \\
 C_9 & 3 & 6 & 1
 \end{matrix}
 \begin{matrix}
 & C_{10} & C_{11} \\
 C_{10} & 1 & 3 \\
 C_{11} & 1/3 & 1
 \end{matrix}
 \begin{matrix}
 & C_{12} & C_{13} \\
 C_{12} & 1 & 2 \\
 C_{13} & 1/2 & 1
 \end{matrix}$$

2.4 Weight Calculation and Consistency Test

The largest eigenvalues λ_{max} for each judgment matrix corresponding eigenvectors ω through normalization becomes the corresponding index for the same level of high-level indicators relative importance of a sort weights. This process is called single-level sorting. In order to ensure the accuracy of judgment matrix, policy makers need to take a consistency test for the judgment matrix. When the consistency proportion CR is less than 0.1, the judgment matrix through consistency test. Otherwise, the judgment matrix should be appropriately modified [3].

Table 2: The results of each judgment matrix consistency test.

Judgment matrix	A-B	B1-C	B2-C
λ_{max}	6.4352	2	2
CI	0.0870	0	0
CR	0.0691	0	0
eigenvectors	(0.2625,0.1548 0.0822,0.0310 0.0734,0.3961) ^T	(0.75,0.25) ^T	(0.8,0.2) ^T
B3-C	B4-C	B5-C	B6-C
2	3.0183	2	2
0	0.0091	0	0
0	0.0176	0	0
(0.75,0.25) ^T	(0.3532,0.1348,0.9258) ^T	(0.75,0.25) ^T	(0.67, 0.33) ^T

Table 3: Single-level sort of each evaluation index.

factors	weight	C7	0.0077
C1	0.1969	C8	0.0030
C2	0.0656	C9	0.0203
C3	0.1238	C10	0.0551
C4	0.0310	C11	0.0184
C5	0.0617	C12	0.2654
C6	0.0206	C13	0.1307

3. APPLICATION OF THE MODEL

Dissipative structures theory mentions that fluctuation resulting in orderly, it is an internal incentive of system evolution. When the system is near a critical point of evolution, some micro-fluctuation will be amplified by nonlinear interactions and cause giant fluctuation to affect the overall movement of the system. Then the system will be unstable, and it is possible to form a new ordered structure in this way. The factors which have greater weights in the Table 3 will have more strongly influence to the investment environment. It is more

likely to form giant fluctuations through diplomatic or other means to affect the greater weights factors.

Petroleum investment environment system is essentially nonlinear. When analyzing the investment environment of the resources country, we can apply the theory of dissipative structures. The mid-1990s, CNPC enter the former Sudan's oil market, then get a lot of original Sudanese oil project, in order to ensure the smooth running of these projects, the CNPC keep giving large-scale aid to original Sudan. According to a research, this behavior greatly promoted the friendship between the two countries and laid a good foundation for the subsequent oil development [4]. The original Sudan split into two independent sovereign states Sudan and South Sudan because of various aspects of conflicts in 2011. What's worse, China's oil project areas are mostly located in the controversial area of Abyei and Darfur. Study showed unfortunately, the oil industry chain is strictly controlled by the northern part [5]. Meanwhile, South Sudan erupted serious internal armed conflict which has seriously impacted the domestic oil production since December 2013.

Oil grade and the difficulty of the exploitation are two natural factors which difficult to change by human in the table 10. Study showed CNPC chosen to invest in the original Sudan could show the two indicators are conducive to our country's investment [6]. To enter the oil industry, CNPC laid a solid foundation in the mid-90s. China's oil companies had entered the oil market of the region at that time. In summary, the political stability, the possibility of military conflict and the level of economic development are the three most important factors currently. It is more likely to form a giant fluctuation to affect these three factors. In this paper, starting from the three indicators, we explore that in what means to promote local oil industry investment environment turn into the dissipative structure which suitable for China's investment.

(1) First, we can help the northern and southern Sudan maintain a stable political situation and reduce the possibility of the military conflict. As a permanent member of the UN Security Council, China should play an active role in the peaceful settlement of the military conflict in South Sudan domestic issues. We should continue to fulfill our obligations to local dispatch peacekeepers to guide the peaceful resolution of internal conflicts in South Sudan and urged the conflicting parties back to the negotiating table to settle disputes by peaceful means. So as to achieve the purpose that making negative entropy flow from the outside of the system and minimal internal entropy.

(2) Secondly, in order to guide the two countries to create a win-win cooperation development model, we can build the minimum entropy within the system.

Based on years of exploration and development results, South Sudan's oil production accounts for 70%~80% of original Sudan whose 98% of revenue comes from oil. However, the oil exports infrastructure is located in the northern. South Sudan must use the pipeline belongs to the North to export crude oil and the pipeline is just decoration without the crude oil. Obviously, no one currently in the north and south sides can "pocketed" all oil revenues. Therefore, the north and south of Sudan's oil investment climate system needs a cooperation to achieve win-win results, otherwise,

the internal system entropy increase is too large, so that the local investment environment becomes more disordered, the ultimate victims are the interests of the Sudanese people.iii) Third, China should focus on investment in human capital in the northern and southern Sudan

cooperation with local oil companies in Sudan to maintain their original advantage. Secondly, we should explore ways of cooperation with other countries to jointly develop oil resources in Sudan.

4. CONCLUSIONS

By Boltzmann's theorem, entropy is a measure of the system confusion degree. The larger it is the more confusion and the more disorderly of the system; conversely, the smaller it is the simpler and the more orderly of the system. Entropy change of the open system consists of two parts, one is the internal system irreversible process producing $diS > 0$, and another is the exchange of material and energy of the system with the outside world deS . The total Entropy change is shown as this function:

$$dS = diS + deS \quad (1)$$

These four measures above strive to make the minimum entropy within the system while the introduction of negative entropy flows from the outside. So that the total entropy of the system is minimized, and it will enable the system reaches a steady state.

According to the theory of dissipative structures, a parameter of the system will form a fluctuation when it changes to a certain threshold value to promote the occurrence of mutations in the system. The system transforms the original chaotic state to a new state which is orderly in space and time. After splitting, the domestic oil industry in Sudan is in chaos. It is more likely to form fluctuations through these four measures to control the factors that affecting the oil industry significantly. So that, the local oil industry investment environment is turned into the dissipative structure which suitable for China's investment.

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