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## **The influencing factors study on environmental responsibility motive of oil and gas enterprises**

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**Abstract:** In China, as heavily polluting enterprises, oil and gas enterprises, while playing a major role in national economy and the people's livelihood, should assume the environmental responsibility of state-owned enterprises. Through in-depth corporate research, the influencing factors of the environmental responsibility motive of oil and gas enterprises are explored. Principal component analysis method was used to reduce dimensionality of influencing factors, extract four main influencing factors. Then the relationship between each influencing factor and the implementation of environmental responsibility of oil and gas enterprises, so as to the relationship between various factors, was analysed in depth, and the causality diagram was creatively drawn according to the system dynamics principle. On this basis, the realisation path of the environmental responsibility dynamic mechanism of oil and gas enterprises is proposed, which is of great significance for promoting the fulfilment of the environmental responsibility of oil and gas enterprises and achieving ecological sustainable development.

**Keywords:** oil and gas enterprise; environmental responsibility; influencing factors; dynamic mechanism.

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Yuanyuan Liu studied in the Department of Nursing, Medical College of Yangtze University, Jingzhou City, Hubei Province in 2008, and officially graduated in 2012. After passing the Unified National Graduate Entrance Examination in 2017, she became a member of the graduate students at the School of Economics and Management of Northeast Petroleum University in Daqing City, Heilongjiang Province. Currently, she is following the tutor to learn accounting expertise systematically, determine the research direction, namely corporate social responsibility, and actively participate in the Daqing City Philosophy and Social Science Planning Research Project and the Northeast Petroleum University Graduate Innovation Research Project.

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## 1 Introduction

As a pillar industry of the country, oil and gas enterprises have important implications for promoting economic development, safeguarding national energy security and improving people's living standards. However, oil and gas enterprises are typically highly polluting industries. In addition to the consumption of basic materials, they also need to consume large amounts of energy and chemicals in the exploration, development, storage, transportation, refining and processing of oil and gas resources. This has an inescapable responsibility for the greenhouse effect caused by global ozone depletion. At the same time, a number of vicious incidents such as oil spills and gas pipeline explosions in recent years have also caused great damage to the ecological environment. Some of the world's well-known environmental pollution incidents are not far away from us, as if they just happened yesterday. For example, the US Gulf of Mexico oil spill on April 20, 2010, the oil spill in CNOOC Bohai Bay in June 2011, the natural gas pipeline explosion in Jinan, Shandong on July 2, 2011, and the Southwestern Guizhou province in July 2017. The natural gas pipeline explosion in Long County, the collision of the Panamanian oil tanker 'sangji' and the Hong Kong-based bulk carrier 'changfeng crystal' on January 6, 2018 and the explosion of the natural gas pipeline in Wisconsin, USA on July 11, 2018 events, etc. The occurrence of these events is extremely harmful to the ecological environment and poses a serious threat to the healthy growth of surrounding biodiversity.

The environmental protection issues of oil and gas enterprises have aroused widespread concern around the world. Governments and environmental protection organisations of all countries have issued relevant rules and regulations, calling for enterprises to fulfil environmental responsibilities, strengthen environmental management, and contribute to the construction of ecological civilisation. The report of the Ninth National Congress in October 2017 proposed that "emphasis should be placed on solving outstanding environmental problems",

“elevate pollution discharge standards, strengthen the responsibility of polluters, improve the system of environmental protection credit evaluation, information disclosure, and severe punishment of heavy penalties, and construct an environmental governance system that is government-led, enterprise-oriented, and social organizations and the public participate together” (Xi, 2017).

It clarified the dominant position of enterprises in environmental governance and raised the environmental responsibility of enterprises to the national strategic height. The academic community has also conducted research on the influencing factors of fulfilling environmental responsibility. Guagnano et al. (1992) proposed that the fulfilment of corporate environmental responsibility is affected by external pressures and internal variables, including government regulatory requirements and liability risks, market opportunities and restrictions, shareholder pressure, etc. Ghobadian et al. (1988) believe that in addition to corporate external pressure and corporate managerial attitudes, corporate environmental responsibility is also constrained by the company’s own factors, such as employee capabilities, available funds and corporate flexibility. Jorge (2005) pointed out that the attitude of managers has a greater impact on whether companies are willing to participate in environmental management. Cho and Patten (2007) research shows that enterprises are forced to disclose the environmental information under public pressure, and the fulfilment of corporate environmental responsibility can help to ease the relationship between enterprises and their communities. These fruitful research results lay a solid foundation for the study of this paper. Therefore, it is of great practical significance and theoretical value to study the influencing factors of environmental responsibility motive of oil and gas enterprises and propose the realisation path of environmental responsibility dynamic mechanism.

## **2 Analysis of the influencing factors of the environmental responsibility motive of oil and gas enterprises**

There are many factors influencing the environmental responsibility of oil and gas enterprises. After studying the existing literature and having entered the company for in-depth research, the author summarises it into three levels according to the influencing factors’ own attributes, a total of 12 factors. Among them, the influential factors at the government level include government legal regulations and government supervision; the social aspects include regional public environmental awareness, media attention, industry association environmental protection regulations and external stakeholders; and corporate-level factors include enterprise scale, corporate profitability, corporate environmental protection culture, sustainable development strategy, cleaner production concept, and environmental funds input. The specific classification is shown in Table 1.

In order to analyse the impact of each influencing factor on the enterprise’s fulfilment of environmental responsibility, in-depth investigations were conducted through the issuance of questionnaires. In the design of the questionnaire, the degree of influence of each factor was divided into seven levels, namely grades 1 to 7, of which level 1 represents the weakest level of influence, level 7 represents the strongest degree of influence, and level 4 is a medium degree of influence. The questionnaire was divided into two forms. Among them, Daqing Oilfield adopted a paper survey questionnaire, and

other provincial oilfields used the ‘questionnaire star’ conduct online research. In order to ensure the rigorousness of the survey results, the subjects are between 23 and 60 years old. The educational background is divided into high school and below, specialties, undergraduate and postgraduate and above. The posts are divided into production operation, professional technology, equipment maintenance and general management personnel. The job positions involve production workers and grassroots managers, middle and senior managers and rear service personnel. In the survey, 185 questionnaires were distributed and 176 were recovered, of which 168 were valid and the effective rate was 91%. It lays a solid foundation for the analysis of the principal components of the sample.

**Table 1** Factors affecting the environmental responsibility motive of oil and gas enterprises

<i>Level</i>	<i>Influencing factors</i>	<i>Code</i>
Government level	Government legal regulations	A1
	Government supervision	A2
Social level	Regional public environmental awareness	A3
	Media attention	A4
	Industry association environmental protection regulations	A5
	External stakeholders	A6
Corporate level	enterprise scale	A7
	Corporate profitability	A8
	Corporate environmental protection culture	A9
	Sustainable development strategy	A10
	Cleaner production concept	A11
	Environmental funds input	A12

### **3 The main influencing factors and relationship analysis of the environmental responsibility dynamic mechanism of oil and gas enterprises**

In order to effectively analyse the motive force for the environmental responsibility of oil and gas enterprises, according to the results of the questionnaire, principal component analysis was used to reduce the dimensionality of 12 influencing factors, extract the main influencing factors of environmental responsibility motive, and analyse the causal relationship between each factor and the fulfilment of environmental responsibility of oil and gas enterprises and the causal relationship between various factors. In accordance with the basic principles of system dynamics, a causality diagram was drawn using Vensim software.

#### *3.1 Analysis of main influencing factors of dynamic mechanism*

##### *3.1.1 Factor fitness analysis*

Based on the survey results of 168 valid questionnaires, a sample observation matrix was established and SPSS 19.0 software was used to calculate the observation matrix to test

the factor fitness. The factor fitness test consists of reliability analysis and validity analysis.

1 Reliability analysis.

The reliability analysis adopts the Cronbach’s reliability coefficient method, and the calculated coefficient is 0.765. The Cronbach’s reliability coefficient based on the standardised term is 0.772, and the reliability value is relatively high (Yang, 2016), as shown in Table 2.

2 Validity analysis

The validity of the questionnaire was analysed by KMO and Bartlett’s test. The KMO test value is 0.754, which is between 0 and 1, and is greater than 0.7, indicating that the index is more suitable for factor analysis. Bartlett’s test of sphericity value is 0.000, less than 0.01, indicating that the variables are independent of each other, and the indices are suitable for factor analysis (Yang, 2016), as shown in Table 3.

**Table 2** Reliability statistics

<i>Cronbach’s alpha</i>	<i>Cronbach’s alpha based on the standardised term</i>	<i>Item</i>
.765	.772	12

**Table 3** KMO and Bartlett’s test

Kaiser-Meyer-Olkin measure of sampling adequacy		.754
Bartlett’s test of sphericity	Approx. chi-square	686.584
	df	66
	Sig.	.000

**Table 4** Total variance explained

<i>Component</i>	<i>Initial eigenvalues</i>			<i>Extraction sum of square loading</i>		
	<i>Total</i>	<i>% of variance</i>	<i>Cumulative %</i>	<i>Total</i>	<i>% of variance</i>	<i>Cumulative %</i>
1	3.560	29.664	29.664	3.560	29.664	29.664
2	2.024	16.866	46.529	2.024	16.866	46.529
3	1.657	13.806	60.335	1.657	13.806	60.335
4	1.347	11.227	71.562	1.347	11.227	71.562
5	.592	4.936	76.498			
6	.533	4.446	80.944			
7	.458	3.820	84.764			
8	.448	3.733	88.497			
9	.405	3.376	91.873			
10	.339	2.828	94.701			
11	.324	2.696	97.397			
12	.312	2.603	100.000			

**Table 4** Total variance explained (continued)

<i>Component</i>	<i>Rotation sum of square loading</i>		
	<i>Total</i>	<i>% of variance</i>	<i>Cumulative %</i>
1	2.668	22.234	22.234
2	2.201	18.342	40.577
3	2.114	17.617	58.194
4	1.604	13.368	71.562
5			
6			
7			
8			
9			
10			
11			
12			

### 3.1.2 Construction of factor load matrix

In order to determine the principal component factor, a sample matrix needs to be constructed, and a correlation analysis is performed on the sample matrix (Dou, 2014). Then the eigenvalues are calculated, and the contribution rate and cumulative contribution rate of the variables are obtained by the eigenvalues, as shown in Table 4.

From the output results, the eigenvalues and variance contribution rates of the matrix R are shown in Table 4. When the common factors reach four, the variance cumulative contribution rate has reached 71.562%, which means that the extraction of the first four common factors is sufficient to summarise most of the information contained in all factors. In order to reduce the complexity of the original data, only the first four factors are extracted as the principal component factors, and the missing information does not affect the analysis results.

### 3.1.3 Verify the linear relationship

The typical representative variables of most factors in the component matrix before rotation are not prominent, and the properties of the factors cannot be well explained. Therefore, it is necessary to rotate the component matrix, as shown in Table 5.

The rotation of the component matrix is to simplify its structure and facilitate the explanation of common factors. In this paper, the varimax rotation method is used to obtain the rotated component matrix. The rotation converges after five iterations, as shown in Table 6.

According to Table 6, it can be found that the factor load of external stakeholders, government supervision, regional public environmental awareness and media attention in component 1 is higher than 0.5, highly related to factor 1, and divided into a category, named 'comprehensive supervision' factor; in component 2, the factor load of environmental funds input, corporate profitability and enterprise scale is higher than 0.5, which is highly related to factor 2, and is divided into a category named 'enterprise development capacity' factor; in component 3, the factor load of cleaner production

concept, corporate environmental protection culture and sustainable development strategy is higher than 0.5, highly related to factor 3, and divided into a category named 'ecological sustainable development' factor; in component 4, the factor load of government legal regulations and industry association environmental protection regulations is higher than 0.5, highly related to factor 4, is divided into a category named 'construction of laws and regulations' factor.

**Table 5** Component matrix

	<i>Component</i>			
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
A4	.714	-.101	-.281	-.207
A3	.707	-.284	-.322	-.093
A6	.681	-.190	-.360	-.270
A2	.674	-.019	-.453	-.193
A7	.600	-.196	.522	.191
A11	.276	.751	.221	-.231
A9	.431	.722	.154	-.115
A10	.361	.623	.236	-.196
A12	.526	-.372	.592	-.025
A8	.519	-.373	.555	.070
A1	.325	.256	-.246	.747
A5	.477	.201	-.140	.693

**Table 6** Rotated component matrix

	<i>Component</i>			
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
A6	.829	.119	.035	-.001
A2	.814	-.014	.134	.126
A3	.789	.219	-.074	.135
A4	.770	.167	.127	.069
A12	.144	.860	.022	-.078
A8	.129	.840	-.017	.013
A7	.130	.799	.120	.195
A11	.000	-.019	.861	.004
A9	.119	.034	.838	.164
A10	.069	.090	.774	.029
A1	.076	-.037	.059	.883
A5	.158	.136	.105	.844

### 3.1.4 Factor score and commonality test

A regression equation was established based on the component score coefficient matrix, and the original variable score of the specific case was brought into the calculation of

each factor score of the case. After the test, the factor scores meet the requirements, and the detailed scores are shown in Table 7.

As can be seen from the commonality of the variables in Table 8, based on the statistical significance of the common degree of variables, it describes the contribution of all common factors to the total variance of the variable X, that is, the ratio of the original variable information explained by the common factors. Therefore, the common factor variance extraction value is between 0.613 and 0.791, which is greater than 0.5, indicating that all variables can be explained by common factors.

From Table 9, it can be seen that the covariance value between the factors are all 0, indicating that the correlation between the factors is low, which further validates that the extracted factors are reasonable.

**Table 7** Component score coefficient matrix

	<i>Component</i>			
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
A1	-.060	-.053	-.051	.588
A5	-.045	.024	-.032	.544
A2	.340	-.123	.018	-.014
A3	.306	.002	-.090	.008
A4	.302	-.024	.018	-.051
A6	.347	-.052	-.023	-.096
A7	-.077	.378	.020	.087
A8	-.057	.407	-.033	-.025
A12	-.045	.416	-.007	-.092
A9	-.009	-.020	.396	.023
A10	-.021	.019	.377	-.059
A11	-.038	-.027	.428	-.073

**Table 8** Communalities

	<i>Initial</i>	<i>Extraction</i>
A1	1.000	.791
A5	1.000	.768
A2	1.000	.697
A3	1.000	.693
A4	1.000	.642
A6	1.000	.702
A7	1.000	.707
A8	1.000	.722
A12	1.000	.766
A9	1.000	.745
A10	1.000	.613
A11	1.000	.742



**Table 9** Component score covariance matrix

Component	1	2	3	4
1	1.000	.000	.000	.000
2	.000	1.000	.000	.000
3	.000	.000	1.000	.000
4	.000	.000	.000	1.000

3.2 Causality analysis of main influencing factors

According to the results of principal component analysis, the factors affecting the environmental responsibility motive of oil and gas enterprises are screened and integrated. The main influencing factors can be summarised into four aspects, namely the construction of laws and regulations, comprehensive supervision, enterprise development capabilities and ecological sustainable development. The construction of laws and regulations and comprehensive supervision are external influencing factors, while the development capabilities of enterprises and ecological sustainable development are internal influencing factors. There is an inevitable causal link between these factors and the environmental responsibility of oil and gas enterprises. Through in-depth investigation and review of relevant literature, the causal relationship between factors and environmental responsibilities, factors and factors was sorted out. In accordance with the principle of system dynamics, a causality diagram was drawn using Vensim software, as shown in Figure 1.

**Figure 1** Dynamic influencing factors causality diagram (see online version for colours)

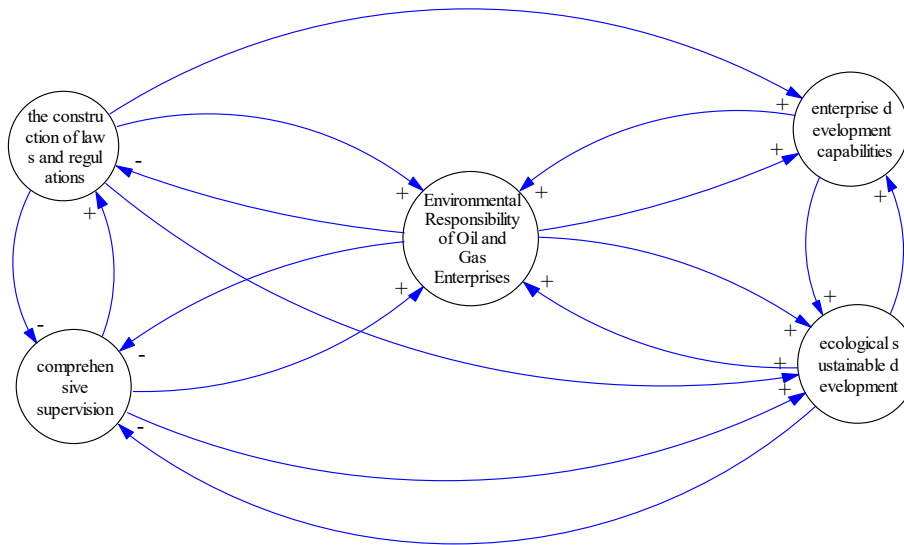


Figure 1 depicts the relationship between the main factors and the environmental responsibility of the oil and gas enterprises, and the relationship between the main factors, where ‘-’ represents negative causation, and ‘+’ represents positive causation.

The figure contains four negative causal relationships, indicating that this is a positive feedback model. In other words, with the construction of laws and regulations, the enhancement of comprehensive supervision, the improvement of the enterprise development capacity and the deepening of the concept of ecological sustainable development, the motive force for enterprises to fulfil environmental responsibility will gradually increase. On the contrary, as the environmental responsibilities of oil and gas enterprises are performed better, it will promote the development of the enterprise development capability and deepen the concept of ecological sustainable development; However, with the better fulfilment of environmental responsibility of oil and gas enterprises, the focus of the construction of regulations and the comprehensive supervision will shift to other fields. This will lead to a negative causal relationship between ‘oil and gas enterprise’s environmental responsibility’ and ‘construction of laws and regulations’, and ‘oil and gas enterprise’s environmental responsibility’ and ‘comprehensive supervision’, which is to reduce the cost of regulation and stimulate the entire society to fulfil its environmental responsibility spontaneously.

At the same time, there is a certain relationship between factors. The construction of laws and regulations can promote the enhancement of the enterprise development capability and the cultivation of ecological sustainable development concepts. Therefore, there is a positive causal relationship between ‘rules and regulations’, ‘enterprise development capability’ and ‘ecological sustainable development’. The promotion of comprehensive supervision can promote the construction of environmental protection regulations and the cultivation of ecologically sustainable development concepts. With the improvement of regulations and the development of the concepts of ecological sustainable development, the focus of comprehensive supervision will shift. So a negative causal relationship is formed between ‘the construction of laws and regulations’ and ‘comprehensive supervision’, ‘comprehensive supervision’ and ‘ecological sustainable development’. The relationship between ‘enterprise development capability’ and ‘ecological sustainable development’ is mutually reinforcing, and there is a positive causal relationship between the two.

#### **4 The realisation path of the environmental responsibility dynamic mechanism of oil and gas enterprises**

According to the above analysis of the influencing factors of the environmental responsibility of oil and gas enterprises, the motive force for enterprises to fulfil environmental responsibility is mainly from the two aspects of external motive and internal motive. Internal and external motive are the interactions, and external motive are gradually transformed into internal motive, which jointly promote the fulfilment of corporate environmental responsibility.

##### *4.1 External motive*

###### *4.1.1 Accelerate the construction of rules and regulations*

Oil and gas enterprises are a huge industry system, and their environmental protection issues are not only the commonness of general industrial enterprises, but also the industry

specificity. At present, China's environmental legal regulations for the petroleum industry adopt a combination of general regulation and special industry regulation. The environmental legal regulation in the process of oil and gas exploration and development are regulated by special legislation. Among them, the 'Environmental Protection Regulations for Offshore Oil Exploration and Development' has been formulated for offshore oil exploration and development. The onshore oil exploration and development has promulgated corresponding local regulations for environmental protection. While other aspects, besides exploration and development, are regulated by general legislation. In the environmental legal regulation, although the relevant provisions on corporate environmental responsibility are regulated discretely, the legal responsibilities that the enterprises should bear cannot be fully clarified, and the legal provisions are inconsistent, which is not conducive to the effective implementation of the law. Therefore, it is necessary to formulate a special 'environmental responsibility law' to coordinate the problems of imperfect legislation and non-uniformity between laws and provisions, to clarify corporate environmental responsibility and obligations, to foster awareness of environmental protection, and to enhance the consciousness of fulfilling environmental responsibility. In order to strengthen the importance of enterprises fulfilling their environmental responsibilities, governments at all levels are encouraged to formulate corresponding rules and regulations, and industry associations are called on to formulate corresponding industry norms. The laws, rules and regulations and industry norms are effectively integrated, which not only has mandatory binding force, but also has flexible operability. It forms a powerful motive force for the implementation of corporate environmental responsibility.

#### *4.1.2 Improve comprehensive supervision*

In order to ensure the effectiveness of environmental responsibility fulfilment for oil and gas enterprises, an environmental responsibility supervision system involving the government, the media and the public should be constructed.

- 1 Government supervision is a key motive force for oil and gas enterprises to fulfil their environmental responsibilities. A special environmental responsibility supervision department should be setup in government agencies to regularly assess and disclose the performance of environmental responsibility of oil and gas enterprises, and use quantitative means to score. Then, enterprises with excellent performance will be rewarded, while those with poor performance will be punished, and the person in charge of the unit will be ordered to rectify within a time limit.
- 2 Media supervision is a direct motive force for oil and gas enterprises to fulfil their environmental responsibilities. The media should publicly report on the environmental information of oil and gas enterprises so that the society can fully understand the implementation of corporate environmental responsibility. In the event of sudden environmental accidents, the media should rule out the pressure of all parties to report news truthfully and let the public know the truth as soon as possible. Enterprises will be under pressure and have to govern them as quickly as possible to reduce the negative impact of pollution.

- 3 The public is the ultimate driving force for oil and gas enterprises to fulfil their environmental responsibilities. Environmental pollution will eventually infringe upon the public's environmental rights, and the public should exert pressure on governments and enterprises through the formal channels. In order to prevent enterprises from facing passive situations, public supervision agencies may be added to the internal management departments of oil and gas enterprises. The representatives of the public are allowed to participate in the formulation of major decisions and to supervise the impact of the decision-making on the environment so as to effectively constrain the enterprises' actions and urge enterprises to consciously fulfil their environmental responsibilities.

## *4.2 Internal motive*

### *4.2.1 Improve the development capabilities of enterprise*

In order to fulfil environmental responsibility, enterprises need to purchase environmental protection equipment, research and develop energy-saving technologies, and establish a sound green production system, which will occupy a large amount of funds. This will force enterprises to improve their competitiveness and enhance their profitability as soon as possible, so that they have enough funds to fulfil their environmental responsibilities. On the contrary, the fulfilment of environmental responsibility will increase the operating costs of enterprises in the short term. However, in the long run, the green production behaviour of enterprises will be generally recognised by the society, and the market share of products will gradually increase. Moreover, with the continuous advancement of environmental protection technology, the cost of environmental protection will gradually decrease, and the fulfilment of corporate environmental responsibility will certainly promote financial performance and ultimately enhance the development capability of the enterprise.

### *4.2.2 Cultivate the concept of ecological sustainable development*

Oil and gas enterprises should always pursue a corporate culture of 'contributing energy and creating harmony', formulate clean, green, economical, safe, and sustainable development strategies, make full use of two resources and two markets so as to ensure national energy security and a stable oil and gas market, provide the society with quality, safe and clean oil and gas products and services, create a resource-saving and environment-friendly enterprise, create harmony between energy and the environment (Party Group of China National Petroleum Corporation, 2013), create a harmonious development of the enterprise and the environment, and a harmonious coexistence between the enterprise and its employees. Under the influence of corporate environmental protection culture, the concept of clean production is integrated into various work processes, and the concept of ecological sustainable development is deeply rooted in the hearts of the people, which will certainly enhance the fulfilment awareness of corporate environmental responsibility.

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