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Evaluation Study on the Institutional System of the New Type of Gas Production and Management Area under the "Oil Company" Model

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Abstract: *With the increase of energy demand, the safety management and operational efficiency of gas extraction operation areas are highly concerned. Taking the Chuanzhongbei Gas Extraction Management Office as a case study, this paper adopts the fuzzy comprehensive evaluation method and the hierarchical analysis method (AHP) to conduct a comprehensive evaluation of its management system system. First, the weights of 17 elements of the system of the new gas extraction management area were assigned by AHP to form a multilevel evaluation system. Subsequently, experts were invited to conduct a fuzzy evaluation, and it was found that the system operated well in general, but there were obvious deficiencies in system design systematicity, applicability and advancement. Therefore, it is recommended that enterprise leaders pay attention to the continuous improvement of the system in order to optimize the management system and enhance the management level.*

Keywords: *Gas Production Management Office, Fuzzy Comprehensive Evaluation Method, Hierarchical Analysis Method*

1. Introduction

In the context of the growing global energy demand, the safety and efficiency of oil and gas extraction operations as key energy resources have become the focus of global attention [1]. Gas production area is the core area of oil and gas exploitation[2]. Its operating environment is complex and changeable [3], , with diverse potential risks. Traditional safety management methods are difficult to meet the needs of modern gas production operations [4], this makes oil and gas exploitation enterprises urgently need to find more scientific and effective management strategies [5].

As an important oil and gas exploitation unit in China, the Gas Production Management Office in north central Sichuan Province undertakes the important task of ensuring energy supply [6]. However, with the increase of mining difficulty, its safety management is facing unprecedented challenges [7]. To ensure the safety and efficiency of gas production operations[8], It is particularly urgent to optimize the existing management system [9]. Therefore, this paper chooses the north central Sichuan gas production management Office as a case study, aiming at fuzzy comprehensive evaluation method [10]and analytic Hierarchy Process (AHP), to clarify the importance of each element in the management system, to provide a clear framework for evaluation [11]. Through the combined application of these two methods, this paper tries to make a comprehensive and objective evaluation of the management system of the gas production management Office in north Central Sichuan Province, and provide scientific guidance for its subsequent improvement [12].

In addition, this paper also combines the international leading occupational health and safety management system (OHSMS) [13], further optimization suggestions for safety management in gas production area are put forward. Through integration with international advanced management concepts [14]. The purpose of this paper is to build a more perfect and efficient safety management system for the gas production management office in north central Sichuan Province, to ensure the safety and efficiency of its gas production operations, and to lay a solid foundation for the sustainable development of enterprises.

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2. Research Design

2.1. Research Methods

2.1.1 Fuzzy comprehensive evaluation method

The weights of the evaluation indicators were determined by the hierarchical analysis method. 10 experts compared the importance of the indicators of the system of the Chuanzhongbei Gas Extraction Management Office two by two and formed a judgment matrix. The scalar value was determined by the collective discussion of the experts. Subsequently, the eigenvectors were calculated and consistency test was carried out. If it was not passed, the judgment matrix was modified and the test was repeated until it was passed.

2.1.2 The analytic hierarchy process determines the weights

The fuzzy comprehensive evaluation method combines fuzzy mathematics and hierarchical analysis and is suitable for solving problems that are multi-factor, multi-level and difficult to quantify. When evaluating the institutional system, it first sets up five levels of rubrics: “very good”, “good”, “average” and “poor”, “very poor” five levels of comment set, and then based on the established indicator system to determine the weights and affiliation matrix, and ultimately through mathematical operations to arrive at the evaluation score. The fuzzy comprehensive evaluation method is widely used in many fields, especially in the evaluation of institutional systems, which can effectively deal with multi-level indicators and make the results clear and quantitative.

2.2. Subjects of the Study and Data Sources

Table 1: Regulation System Evaluation Indicator System.

Level 1 indicators	Secondary indicators	Tertiary indicators
A Design Levels	A1 Systemic	A11 Degree of institutional support
		A12 Degree of operational coverage
		A13 Duplication or conflict situations
	A2 Compliance	A21 legality
		A22 Consistency with superior regulations
		A23 Professional ethics
	A3 Applicability	A31 Degree of applicability to regulatory bodies
		A32 Degree of applicability in relation to competence
		A33 Degree of applicability to the process
	A4 Advancement	A41 Degree of compliance with regulatory laws
		A42 Promotion of management improvement
		A43 Managing deficiencies
	A5 Validity	A51 Degree of effective implementation
		A52 Fulfillment of implementation requirements
B Implementation levels	B1 Dissemination and implementation	B11 Frequency of sensitization and training
		B12 Effectiveness of sensitization and training
	B2 Implementation	B21 Implementation of implementation responsibilities
		B22 Implementation effects
	B3 Monitoring and rectification	B31 Monitoring of the implementation process
		B32 Rectification of non-conformity

The object and scope of this system evaluation include the design level as well as the implementation level of the 64 rules and regulations that have been optimized by the management office in FY2022. In order to ensure the comprehensiveness, significance, operability and effectiveness of the evaluation indicators of the system, Chuanzhongbei Gas Extraction Management Office specially invited an evaluation expert group consisting of 10 internal experts of the Company. These experts cover the company's middle and senior managers as well as grassroots personnel, and they have in-depth understanding and rich experience in internal control. Based on the specific business and basic situation

ISSN 2616-5902 Vol. 6, Issue 7: 46-51, DOI: 10.25236/AJBM.2024.060706

of Chuanzhongbei Gas Extraction Management Office, the expert group finalized the evaluation index system of the institutional system which contains three levels of evaluation index system, covering the evaluation level, evaluation content and specific indexes, in order to ensure the accuracy and effectiveness of the evaluation results. The evaluation index system of the institutional system is shown in Table 1.

3. Empirical Research

3.1. Determining Evaluation Indicator Weights Using Hierarchical Analysis

The weights of the evaluation indicators are determined by hierarchical analysis, and the 10 experts of the expert group compare the importance of each element of the indicator system of the system of the Chuanzhongbei Gas Extraction Management Office two by two to get the judgment matrix, and the importance scale value between each element is given by the 10 members of the expert group after collective study and discussion. Finally, the weighting table of the evaluation indicators of the system of the Chuanzhongbei Gas Extraction Management Office is obtained, as shown in Table 2.

Table 2: Table of weights of indicators for evaluation of the institutional system.

Level 1 indicators	Weights	Secondary indicators	Weights	Tertiary indicators	Weights
A Design Levels	0.5	A1 Systemic	0.27	A11	0.29
				A12	0.14
				A13	0.57
		A2 Compliance	0.47	A21	0.58
				A22	0.31
				A23	0.11
		A3 Applicability	0.15	A31	0.11
				A32	0.26
				A33	0.63
		A4 Advancement	0.04	A41	0.23
				A42	0.12
				A43	0.65
		A5 Validity	0.07	A51	0.6
				A52	0.4
B Implementation levels	0.5	B1 Dissemination and implementation	0.1	B11	0.3
				B12	0.7
		B2 Implementation	0.33	B21	0.4
				B22	0.6
		B3 Monitoring and rectification	0.57	B31	0.6
				B32	0.4

3.2. Determination of the Affiliation Matrix of Indicators for the Evaluation of The Institutional System

The establishment of affiliation matrix needs to first set the set of comments, this paper selects the more commonly used “very good”, “good”, “general”, “poor”, “very poor” five grades as the comments of the indicators at all levels of the system of the Chuanzhongbei Gas Extraction Management Office, and use V1,V2,V3,V4,V5 to express respectively, geting the rubric set $V=\{V_1,V_2,V_3,V_4,V_5\}$. After setting the set of rubrics, it is necessary to assign values to the set of rubrics, which are $V_1=1.0$, $V_2=0.8$, $V_3=0.6$, $V_4=0.4$, $V_5=0.2$. In determining the degree of affiliation, the 10-member expert group will discuss and study. Each member will select and assign the value to the rubrics of each three-level indicator according to the investigation and understanding of the Chuanzhongbei Gas Extraction Management Office, and then calculate the degree of affiliation. That is V_i, the degree of affiliation is the value obtained by dividing the number of experts selecting the rubrics by the total number of experts in the expert group. The following Table 3 and 4 is the final table of evaluation index affiliation.

ISSN 2616-5902 Vol. 6, Issue 7: 46-51, DOI: 10.25236/AJBM.2024.060706

Table 3: Affiliation degree of three-level indicators at the design level of the system of the Chuanzhongbei Gas Extraction Management Office.

Secondary indicators	Tertiary indicators	degree of affiliation				
		good	better	general	mediocre	poorly
A1 Systemic	A11	0.2	0.5	0.3	0	0
	A12	0.3	0.4	0.3	0	0
	A13	0	0.1	0.7	0.2	0
A2 Compliance	A21	0.9	0.1	0	0	0
	A22	0.4	0.5	0.1	0	0
	A23	0.6	0.4	0	0	0
A3 Applicability	A31	0	0.4	0.4	0.2	0
	A32	0	0.2	0.6	0.2	0
	A33	0.1	0.2	0.5	0.2	0
A4 Advanced	A41	0.2	0.2	0.4	0.2	0
	A42	0.1	0.1	0.5	0.2	0.1
	A43	0	0.3	0.6	0.1	0
A5 Validity	A51	0.1	0.2	0.5	0.2	0
	A52	0.2	0.3	0.5	0	0

Table 4: Affiliation degree of the three-level indicators at the implementation level of the system of the Chuanzhongbei Gas Extraction Management Office.

Secondary indicators	Tertiary indicators	degree of affiliation				
		good	better	general	mediocre	poorly
B1 Dissemination and implementation	B11	0.4	0.5	0.1	0	0
	B12	0.1	0.4	0.5	0	0
B2 Implementation	B21	0.1	0.3	0.6	0	0
	B22	0.2	0.4	0.4	0	0
B3 Monitoring and rectification	B31	0.3	0.6	0.1	0	0
	B32	0.1	0.2	0.6	0.1	0

3.3 Fuzzy Comprehensive Evaluation of the System of the Chuanzhongbei Gas Extraction Management Office

Table 5: Scores for indicators at the institutional system design level at each level.

Level 1 indicators	Score	Secondary indicators	Score	Tertiary indicators	Score
A Design Levels	0.79	A1 Systemic	0.67	A11	0.78
				A12	0.8
				A13	0.58
		A2 Compliance	0.94	A21	0.98
				A22	0.86
				A23	0.92
		A3 Applicability	0.63	A31	0.64
				A32	0.6
				A33	0.64
		A4 Advancement	0.64	A41	0.68
				A42	0.58
				A43	0.64
		A5 Validity	0.68	A51	0.64
				A52	0.74

Table 6: Scores for indicators at all levels of implementation of the institutional system.

Level 1 indicators	Score	Secondary indicators	Score	Tertiary indicators	Score
B Implementation level	0.76	B1 Dissemination and implementation	0.76	B11	0.86
				B12	0.72
		B2 Implementation	0.74	B21	0.7
				B22	0.76
		B3 Monitoring and rectification	0.77	B31	0.84
				B32	0.66

After obtaining the affiliation matrix of the evaluation indicators of the institutional system, the scores

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of each indicator can be calculated by multiplying the affiliation matrix with the set of rubrics that have been set, and the specific results are shown in Tables 5 and 6.

Through the evaluation and scoring of the indicators at all levels of the system of the Chuanzhongbei Gas Extraction Management Office, a total evaluation score was obtained $S=[0.5,0.5]\times[0.79,0.76]^{T}=0.77$.

3.4. Analysis of the Evaluation Results of the System of the Chuanzhongbei Gas Extraction Management Office

Using the fuzzy comprehensive evaluation method to evaluate, the final comprehensive score of the system of the Chuanzhongbei Gas Extraction Management Office is 0.77, which is at the level of "general", indicating that the system of the management office is running well in general, and the system basically protects the daily operation of the management office.

The rating of the system design level of the management office is 0.79, which is in between good and general level, and the ratings of other indicators are less than 0.7 except the rating of compliance (A2) which is 0.94, indicating that the system of the management office of the gas extraction system of the north of the central Sichuan Province needs to be further strengthened in terms of systematicity, applicability, advancement, and effectiveness.

The rating of the implementation level of the management system is 0.76, which is between good and average level. There are a total of three indicators at the implementation level, the publicity and implementation (B1) scored 0.76, the implementation (B2) scored 0.74, and the supervision and rectification (B3) scored 0.77, all of which are between good and average. This shows that the implementation of the system plan may not be rigorous enough, the system of publicity and training to be further strengthened; the mechanism for monitoring the implementation of the system has to be further clarified and effectively implemented.

The fuzzy comprehensive evaluation of the system of the Chuanzhongbei Gas Extraction Management Office shows that the design and implementation of the system are "better", indicating that it has set up a better system and implemented it effectively. However, there is still room for improvement in terms of systematicity, applicability, advancement and effectiveness at the design level, and it is recommended that the system be continuously optimized and synergies between systems be strengthened. Although the implementation level is well executed, some employees do not have a high level of understanding and recognition of the system, and training and supervision mechanisms need to be strengthened to ensure the effective implementation of the system. Therefore, it is recommended to continue to pay attention to and improve the system to enhance its ability to support the safety management and operational efficiency of the Gas Production Operation Area.

4. Conclusions and Suggestions

4.1. Conclusions

In this study, we conducted a comprehensive and systematic evaluation study of the management system of the gas extraction operation area by using the fuzzy comprehensive evaluation method and hierarchical analysis method. By constructing a multi-level qualitative index evaluation system and inviting experts to evaluate the 17 elements, we draw the following conclusions:

(1) The consistency test is passed. the largest eigenvalue of the judgment matrix constructed by 10 experts' evaluation is 10, and the consistency ratio is 0, which is less than 0.1, showing that the consistency of the evaluation process is strong and the evaluation results are reliable.

(2) Overall operation is good. The management system of the Gas Production Operation Area operates well in general, and the scores of the three aspects of "planning", "implementation and operation" and "inspection and corrective measures" are all at the level of good to excellent, showing that the enterprise is in a good position in terms of "planning", "implementation and operation" and "inspection and corrective measures". The scores for "planning", "implementation and operation" and "inspection and corrective measures" are all at the good to excellent level, showing that the enterprise's management system in these areas is relatively effective.

(3) Some deficiencies exist. However, the enterprise's low score in "systematic, applicable and

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advanced system design" shows that there are serious deficiencies in system design, which need to be highly emphasized by the enterprise's leaders.

4.2. Suggestions

Based on the above conclusions, we make the following recommendations:

(1) Improve the management review mechanism. Enterprises should establish a sound management review mechanism and regularly review and update the management system to ensure its continuous effectiveness. At the same time, strengthen the analysis and application of the review results, and formulate and implement timely improvement measures for the problems found in the review.

(2) Strengthen employee training and awareness-raising. Enterprises should strengthen occupational health and safety training for employees to improve their safety awareness and operation skills. At the same time, through regular safety culture activities, etc., to create a good atmosphere for all employees to participate in safety management.

(3) Continuously optimize the management system. Enterprises should continue to pay attention to advanced management concepts and practical experience at home and abroad, and study and learn from them in combination with the actual situation of the enterprise. At the same time, employees are encouraged to put forward improvement suggestions and recommendations to continuously optimize the management system and enhance the overall management level of the enterprise.

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