Study on Environmental Performance Evaluation Model of Coal Mine Using Balanced Scorecard and Ubiquitous Computing

Xizhen Gao, Xiao He*
School of Management, Tianjin University of Technology, Tianjin, China

*Corresponding author: xiaohe2019@tjut.edu.cn

Abstract. Based on the analysis of the current situation of environmental performance evaluation of coal enterprises in China, this paper uses the Balanced Scorecard as the basic framework to comprehensively evaluate environmental performance from the dimensions of environmental finance, internal environmental management, stakeholders and learning and growth. Set up a number of indicators in each dimension, use AHP to determine the weights of indicators at all levels, and test the rationality of index weights through consistency, and establish a comprehensive environmental performance evaluation system.

Keywords: Balanced scorecard, Environmental performance, Coal enterprise.

1. Introduction
Coal is China's main energy, which is related to the national economic lifeline and the importance of energy security. Coal enterprises have supported the rapid development of China's national economy for a long time. At the same time, in the process of exploiting and utilizing coal resources, coal enterprises have caused problems such as waste of resources and environmental pollution. This makes coal enterprises suffer from social criticism at the same time.

How to effectively analyse and control the environmental problems of coal enterprises has become a top priority in environmental protection. Therefore, exploring environmental performance evaluation indicators, establishing an environmental performance evaluation system for heavily polluted industries and measuring the environmental performance of enterprises can find potential motivation for enterprises to reduce environmental pollution, provide basis for improving environmental protection efficiency and promote the long-term development of coal enterprises.

2. Problems in environmental performance evaluation of coal enterprises
2.1. environmental performance information is scattered
By comprehensively sorting out the environmental information in the social responsibility reports of coal listed enterprises in recent years, it is found that the contents of environmental information disclosure by coal enterprises are too scattered and not concentrated, and they are basically non-financial information. For how much money has been invested to control environmental pollution, there is very
little financial information involved in the discharge of pollutants such as sewage and air pollutants, and the environmental performance and economic performance are not coordinated and unified.

2.2. Lack of effective environmental performance evaluation system

At present, the environmental performance evaluation of Chinese coal enterprises is still in the primary stage, lacking a unified measurement standard and a perfect evaluation system. Although the latest ISO14031 environmental performance evaluation standard was promulgated by the International Organization for Standardization in 2013, which provides a reference basis for coal enterprises to evaluate environmental performance, the comparability is weak, which cannot directly reflect the economic benefits, so it cannot motivate environmental managers to participate in environmental protection.

2.3. Index selection is unreasonable

In the environmental performance evaluation of coal enterprises, there is a lack of logic and relevance in the selection of indicators, which are mainly selected by the government, but not according to the actual situation, such as energy consumption per unit output value, waste emissions, etc. Moreover, the evaluation results of many indicators only reach the standard, and there is no more in-depth evaluation and research, and there is no effective combination of qualitative indicators and quantitative indicators.

3. Design of evaluation index system

3.1. Design of evaluation index system

3.1.1. Environmental financial dimension. According to the characteristics of daily production activities and operation process of coal enterprises, three indexes, i.e., environmental governance investment, environmental protection investment return rate and environmental protection investment cost ratio, were selected. Investment in environmental governance refers to the amount invested by enterprises in environmental pollution control in order to achieve the goal of sustainable development. The rate of return on environmental protection investment refers to the profit created by environmental protection investment/the investment amount of environmental protection equipment. The cost ratio of environmental protection investment is enterprise environmental prevention investment/enterprise gross output value × 100%. According to the cost ratio of environmental protection investment, the ratio of the cost invested by enterprises in environmental protection prevention and control investment to the total cost can be made clear.

3.1.2. Dimension of internal environmental management. The key of internal environmental management is to measure the compliance of environmental protection laws, mechanism construction and implementation, environmental protection technology and process, pollutant treatment and so on. Based on this, three indicators were selected: environmental protection attitude and concept, dust emission per unit output value and three wastes treatment rate. Environmental protection attitude and philosophy are mainly reflected in the formulation and implementation of environmental protection regulations. Dust emission per unit output value refers to the dust emission per unit coal production. The treatment rate of the three wastes refers to the proportion of the treatment amount of waste water, waste gas and waste residue in the total discharge amount of the three wastes.

3.1.3. Stakeholder Dimension. Stakeholder dimension refers to the scientific supervision of the normal production and operation activities of enterprises by relevant stakeholders, and selects three indicators: customer satisfaction, the number of environmental pollution complaints and environmental information disclosure. Customer satisfaction refers to the public's satisfaction with the environmental protection status and environmental management behaviour at various stages of enterprise operation and management. The number of complaints about environmental pollution refers to the number of
complaints from surrounding residents about environmental pollution and destruction. Environmental information disclosure refers to the behavior that enterprises publish environmental information to the public in the form of reports and announcements according to the law.

3.1.4. Dimensions of Learning and Growth. This dimension mainly selects three indicators: investment in environmental protection R&D, proportion of R&D personnel, and environmental protection training of staff. Environmental protection R&D investment refers to the total amount of funds invested by enterprises in environmental protection R&D in a given year. The proportion of R&D personnel refers to the proportion of R&D personnel to the total employees of the company. Staff environmental protection training refers to the popularization and publicity of staff environmental protection knowledge when enterprises carry out production and business activities.

To sum up, considering the difficulty of obtaining different indicators, 12 indicators that have an impact on environmental performance were selected. Classify all kinds of indicators, clarify their levels and finally determine the hierarchical structure of environmental performance, as shown in Table 1.

Table 1. Environmental performance evaluation index system.

| Target layer | Criterion layer | Index layer |
|--------------|-----------------|-------------|
| Environmental performance evaluation index system | Environmental finance | Investment in environmental governance yield |
| | | Environmental protection investment cost ratio |
| | Internal environmental management | Attitude and concept of environmental protection |
| | | Dust emission per unit output value |
| | | Treatment rate of three wastes |
| | Stakeholders | Customer satisfaction rate |
| | | Number of environmental pollution complaints |
| | | Environmental information disclosure |
| | Learning and growth | Investment in environmental protection research and development |
| | | Safety production training times |
| | | Employee turnover rate |

3.2. Determination of Index Weight of Environmental Performance Evaluation
Analytic hierarchy process is used to calculate each weight value, and 1-9 scale method is used to construct judgment matrix, as shown in Table 2 to Table 5.

Table 2. Analytic hierarchy process scale type.

| Standard type | Equal importance | Slightly important | More important | very important | Absolutely important | mean value |
|---------------|------------------|--------------------|----------------|----------------|----------------------|------------|
| Quantized value | 1                | 3                  | 5              | 7              | 9                    | 2,4,6,8    |
Table 3. Judgment matrix of environmental performance dimension evaluation index.

| Environmental finance | Internal environmental management | Stakeholders | Learning and growth |
|-----------------------|----------------------------------|--------------|---------------------|
| Environmental finance | 1                                | 2            | 4                   |
| Internal environmental management | 1/2                          | 1            | 2                   |
| Stakeholders          | 1/4                              | 1/2          | 1                   |
| Learning and growth   | 1/5                              | 1/4          | 1/3                 |

The eigenvector of matrix A is obtained by matrix operation, and the maximum eigenvalue of A is calculated: \( \lambda_{\text{max}} = 1/4(2.094/0.461 + 1.15/0.288 + 0.64/0.183 + 0.29/0.068) = 4.05 \)

Secondly, calculate the consistency index. The judgment matrix of factors to targets is a 4 × 4 matrix, so \( n = 4 \), \( \text{C.I.} = (\lambda_{\text{max}}-n)/(n-1) = (4.05-4)/(4-1) = 0.017 \). The random consistency index is queried to obtain the R.I. value, R.I. = 0.9. As shown in Table 4:

Table 4. Random consistency index

| n  | R1  |
|----|-----|
| 1  | 0.00|
| 2  | 0.00|
| 3  | 0.58|
| 4  | 0.90|
| 5  | 1.12|
| 6  | 1.24|
| 7  | 1.32|
| 8  | 1.41|

According to C.I. and R.I. the consistency ratio C.R. is calculated. C.R.=C.I./R.I.= 0.017/0.9 = 0.019. Because C.R.<0.1, the consistency of the four dimensions passed the test. Therefore, the weight scores of the four dimensions are 46.1%, 32.7%, 13.8% and 7.5%. After the consistency of the four dimensions has passed the test, we should also carry out hierarchical analysis on each index of the four dimensions and carry out the consistency test. The calculation method is the same as before and will not be repeated. The final results are shown in Table 5.

Table 5. Environmental performance evaluation index system

| Target layer | Criterion layer | Weight | Index layer | Weight |
|--------------|-----------------|--------|-------------|--------|
| Environmental performance evaluation index system | Environmental finance | 0.461 | Investment in environmental governance | 0.24 |
| | | | Environmental protection investment yield | 0.62 |
| | | | Environmental protection investment cost ratio | 0.12 |
| | Internal environmental management | 0.288 | Attitude and concept of environmental protection | 0.10 |
| | | | Dust emission per unit output value | 0.27 |
| | | | Treatment rate of three wastes | 0.63 |
| | Stakeholders | 0.183 | Customer satisfaction rate | 0.49 |
| | | | Number of environmental pollution complaints | 0.37 |
| | | | Environmental information disclosure | 0.14 |
| | Learning and growth | 0.068 | Investment in environmental protection research and development | 0.45 |
| | | | Safety production training times | 0.28 |
| | | | Employee turnover rate | 0.27 |
It can be seen from the weight calculation results in Table 5 that the relative weight of the environmental finance dimension reaches 46.1%, which shows that the environmental finance dimension accounts for a large proportion. Enterprises need to link environmental matters with financial matters, so as to promote enterprises to do a good job in environmental protection while obtaining the maximum economic benefits as much as possible, and realize resource conservation and environment-friendly sustainable development.

The weight of internal environmental management dimension is 28.8%, which reflects the implementation of environmental supervision and governance within enterprises and occupies an important position in environmental performance evaluation. The ratio of pollutant discharge to treatment can reflect the ability and treatment effect of enterprises in environmental treatment, and it is a key indicator for evaluating the environmental performance of enterprises.

Stakeholder dimension and employee weight are 18.3%. The development of enterprises is always inseparable from the support of stakeholders, so enterprises have the obligation to bear corresponding social responsibilities to stakeholders.

The weight of learning and growth dimension is 6.8%. Facing the global climate change situation, the worldwide energy strategy will undergo great changes under the constraint of carbon emissions. Coal enterprises can't just be satisfied with the existing technology and ability, and it is urgent to increase investment in enterprise learning and growth ability.

4. Conclusion
Under the current sustainable development background, it is urgent to evaluate the environmental performance of coal enterprises. Environmental performance evaluation plays an irreplaceable role for both internal managers and external information users. Environmental performance evaluation based on balanced scorecard is an evaluation system based on comprehensive consideration of internal and external factors of enterprises. It is not only a means of performance evaluation, but also a strategic management tool, which can not only obtain financial benefits, but also comprehensively manage enterprises in the implementation process.

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