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Design and Application of Evaluation Indicators for Accounting Information Disclosure of Chemical Companies

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Environment accounting information disclosure is an important means for chemical companies to solve environmental pollution problems. However, currently, in China, the environment accounting information disclosure system of chemical companies has not been established, there are still many existing problems, however, it's necessary to further study the company environment accounting information disclosure system in-depth. This paper mainly analyzes and studies the evaluation indicator system of accounting information disclosure of chemical companies based on the Analytic Hierarchy Process (AHP) theory. The research results show that, as a whole, the disclosure level of environment accounting information of chemical companies is not high, and there is a big gap between the levels of environment accounting information disclosure among different chemical companies. The 10 items of environment accounting information disclosure were divided into three dimensions: relevance, saliency, and reliability, and a quality evaluation system for the accounting information disclosure of chemical companies was established, through analysis, it's found that the degree of importance was: relevance, reliability, saliency. In addition, out of the 10 indicators, corporate pollutant emissions and auditing of environment accounting information accounted for higher weights.

1. Introduction

Chemical industry is an important part of China's national economy, but it is also one of the most polluting industries. Environmental pollution caused by chemical companies in the course of production and management seriously hinders their own sustainable development (Lambert et al., 2007). At present, energy conservation, emission reduction and environmental protection have become important issues for chemical companies, and environment accounting information disclosure is an important means for chemical companies to solve environmental pollution problems (Wang et al., 2014). Good disclosure of environment accounting information will enable consumers to increase their confidence in the company and establish a good corporate image. At present, the environment accounting information disclosure system of China's chemical companies has not been established, there are still many existing problems, therefore, it's necessary to further study the company environment accounting information disclosure system in-depth (Zhu et al., 2017). For the research on accounting information disclosure, experts and scholars at home and abroad have formed a series of research results, mainly including: research on environment accounting theory (Ro, 1980; Trueman, 1987); research on the influencing factors of environment accounting information disclosure (Iatridis, G. 2008; Einhorn and Ziv, 2007); research on forms and contents of environment accounting information disclosure (Ferguson et al., 2002; García and García-García, 2010). This paper is mainly based on the AHP theory, and it establishes an evaluation indicator system for accounting information disclosure of chemical companies. This has certain guiding significance and practical value for the disclosure of accounting information in the chemical industry.

2. Introduction of AHP theory

Analytic Hierarchy Process (AHP) combines quantitative analysis with qualitative analysis and analyzes multi-objective decision-making by calculating the weight of each target, so as to determine the merits of each solution (Yahya and Kingsman, 1999). The analysis steps of AHP are:

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2.1 Establish a hierarchical structure model

The overall target is stratified and is usually divided into target layer, standard layer, and scheme layer (Kulak and Kahraman, 2005), as shown in Figure 1.

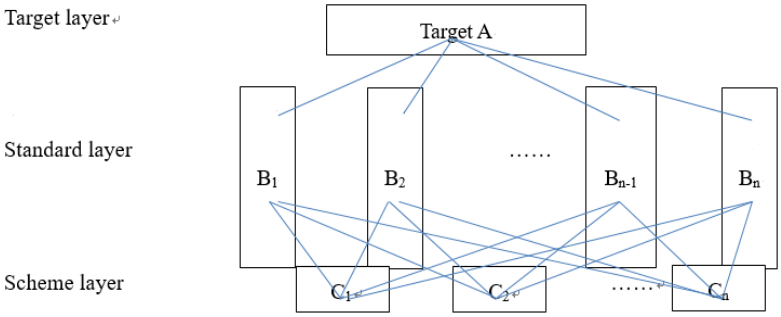

Figure 1: Hierarchical structure model

2.2 Construct a judgment matrix and solve the maximum eigenvalue and eigenvector

Through comparison with each other to determine the weight of each standard layer for the target, namely to establish a judgment matrix. In AHP, in order to enable the importance of each element in the matrix to be quantitatively displayed, a matrix judgment scale is generally adopted, namely the 1-9 scaling method (Ramanathan, 2001), its specific meaning is shown in Table 1.

Table 1: The scale of judgment matrix and its meaning

Scale	Meaning
1	The two factors are equally important
3	A factor is more important than the other factor when compared to the two factor
5	A factor is obviously more important than the other factor when compared to the two factor
7	A factor is strongly more important than the other factor when compared to the two factor
9	A factor is extremely more important than the other factor when compared to the two factor
2, 4, 6, 8	The median value of the two adjacent judgments
reciprocal	The two factor is the reciprocal of the original comparative value

The maximum eigenvalues and eigenvectors of the judgment matrix are calculated using the geometric mean approximation (Han, B., et al. 2013). The calculation steps are:

(a) Calculate the product of each factor of each row of the matrix: $m_i = \prod_{i=1}^{n} a_{ij} \quad i = 1,2,\dots,n;$

(b) Calculate the n-th root: $\overline{w_i} = \sqrt[n]{m_i};$

(c) Normalize the vector: $\overline{w_i} = (\overline{w_1}, \overline{w_2}, \cdots \overline{w_n})^T$, $w_i = \frac{\overline{w_i}}{\sum_{j=1}^{n} \overline{w_j}} \quad j = 1,2,\dots,n$

The obtained $w_i = (w_1, w_2, \cdots, w_n)^T$ are the approximate values of the eigenvectors, namely the weights of each factor.

(d) Calculate the maximum eigenvalue λmax of the judgment matrix: $\lambda max = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i}$.

2.3 Consistency test of hierarchical single-ranking

The factors in the same layer are compared in pairs taking factors of above layer as the standards, and the weights of the indicators at this layer are obtained and subjected to the consistency test (Bevilacqua & Braglia, 2000). The formula of consistency indicator is: $CI = \frac{\lambda max - n}{n-1}$.

Table 2: Average consistency indicator

N	3	4	5	6	7	8	9	10	11	12
K_n	0.053	0.087	0.106	0.127	0.133	0.139	0.146	0.148	0.152	0.153

Where, λmax is the maximum eigenvalue of the characteristic equation, and n is the order of the judgment matrix. The value rules are shown in Table 2.

The random consistency ratio is represented by CR, CR=CI/RI. For a judgment matrix of order n>2, if CR<0.1, it can be considered that it passes the consistency test, indicating that the judgment matrix has satisfied consistency. If CR≥0.1, the judgment is inconsistent (Dağdeviren and İhsan Yüksel. 2008). At this point, the judgment matrix needs to be adjusted until a satisfied consistency has been reached.

2.4 Hierarchical total ranking

Calculate the ranking weights of all elements of the index layers for the relative importance of the highest layer, thus forming the absolute weight of each element for the total target.

3. Empirical analysis of environment accounting information disclosure

3.1 Overall situation of environment accounting information disclosure in the chemical industry

Since chemical companies use a large amount of chemical raw materials during the production process, it would cause severe pollutions to the environment.
By the end of 2017, there are 293 listed chemical companies in Shanghai and Shenzhen stock market of China, which are mainly divided into three categories: petrochemical enterprise, basic chemical enterprise and chemical fiber enterprise, the respective proportions are shown in Figure 2.

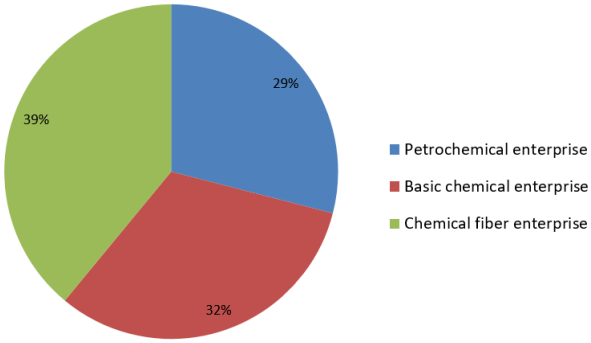

Figure 2: Classification of enterprises in chemical industry

With the continuous improvement of environmental protection requirements, the number of chemical companies that disclose their environment accounting information has been increasing, as shown in Figure 3.

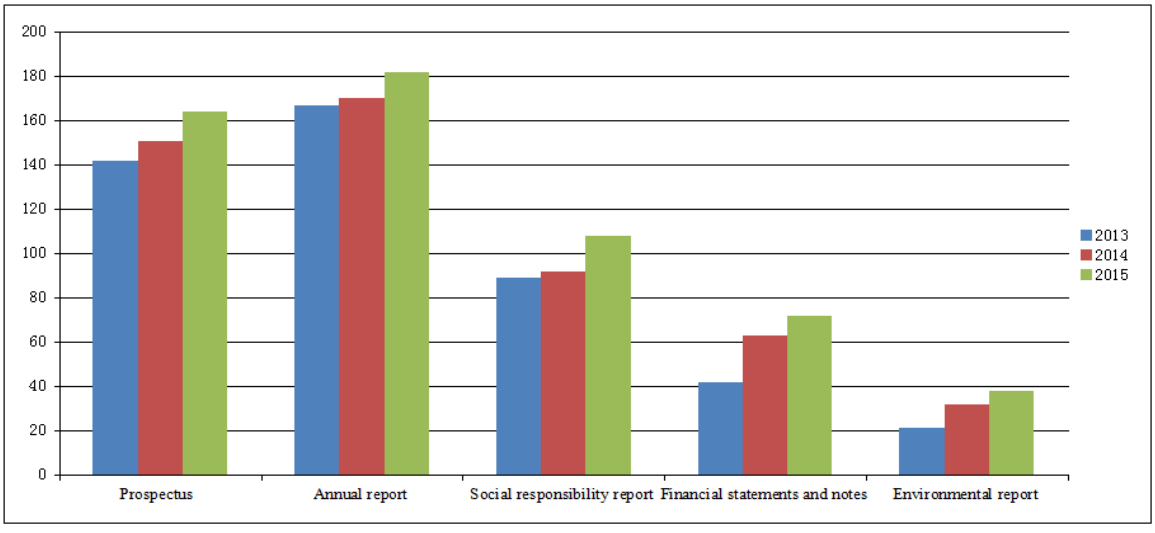

Figure 3: Comparison chart of environment accounting information disclosure carrier in chemical companies

3.2 Design and application of evaluation indicators for accounting information disclosure of chemical companies

(1) Establish indicator evaluation system

In this paper, the 10 items in the environment accounting information disclosure are divided into three dimensions: relevance, saliency, and reliability. An accounting information disclosure quality evaluation system for chemical companies is established. The entire indicator evaluation system consists of three layers: target layer (A), index layer. (B) and project layer (C), see Table 3 for details.

Table 3: Quality indicators of environment accounting information disclosure of chemical companies

Target layer (A)	Index layer(B)	Project layer (C)
Quality of environmental accounting information disclosure (A)	Relevance (B_1)	The company's environmental policy, goals, etc(C_1)
		The annual resource consumption of the company(C_2)
		Investment in construction of environmental protection facilities(C_3)
		Emission of pollutants in Enterprises(C_4)
		Government subsidies related to environmental protection(C_5)
		Other environmental accounting information(C_6)
	Saliency (B_2)	Preparation of independent reports(C_7)
	Reliability (B_3)	Authentication of independent third party(C_8)
		Environmental accounting information audit(C_9)
		Environmental information quality assurance related instructions(C_{10})

(2) Determine the judgment matrix

Through the method of expert rating, the relative importance of the three dimensions of environment accounting information disclosure quality is judged, and questionnaires are distributed to experts in the chemical field and analyzed after collection. The specific results are shown in Table 4.

Table 4: Expert rating index layer comparison table

Index comparison	More important standards	Importance	Numeric grade
Relevance and Reliability	Relevance	important	2
Relevance and Saliency	Relevance	Very important	4
Reliability and Saliency	Reliability	important	3

As can be seen from Table 4, the importance of environment accounting information disclosure quality of chemical companies in the hierarchy analysis structural model is: relevance, reliability, and saliency. This also reflects the reliability of current environment accounting information disclosure of chemical companies is not high. Therefore, the comparison matrix B of the weight of each quality feature of environment accounting information disclosure is a third-order matrix, that is:

$$\mathrm{B} = b_{ij} = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix} = \begin{bmatrix} 1 & 4 & 2 \\ \frac{1}{4} & 1 & 1/3 \\ \frac{1}{2} & 3 & 1 \end{bmatrix}$$

(3) Hierarchical single-ranking of the index layer of environment accounting information disclosure quality

First calculate the weights:

$$M_i = \prod_{j=1}^{n} b_{ij} = \begin{bmatrix} 8 \\ \frac{1}{12} \\ 3/2 \end{bmatrix}$$

Calculate the third-root $\overline{W_i}$ of M_i: $\overline{W_i} = \sqrt[n]{M_i} = \begin{bmatrix} 2 \\ 0.5237 \\ 1.2468 \end{bmatrix}$

Perform normalization processing on vector $\overline{W} = (\overline{W_i}, \overline{W_2}, \cdots, \overline{W_n})^T$, we can get: $\mathrm{W} = \frac{\overline{W_i}}{\sum_{i=1}^{n} \overline{W_i}} = \begin{bmatrix} 0.6014 \\ 0.1347 \\ 0.2639 \end{bmatrix}$

Therefore, the weights for relevance, saliency, and reliability are 0.6014, 0.1324, and 0.2639, respectively. Calculating the maximum eigenvalue λmax yields λmax = 3.0146.

(4) Perform consistency test on hierarchical single-ranking

$\mathrm{CI} = \frac{\lambda\max - \mathrm{n}}{n-1} = \frac{3.0146-3}{3-1} = 0.0073$, combining with the data in Table 3, it can be found that CI = 0.0073 <k_3 = 0.053, therefore, the judgment matrix B satisfies and passes the consistency test.

(5) Hierarchical single-ranking of the project layer of environment accounting information disclosure quality

First, calculate the weight of the project layer under the relevance indicators, and use the method of expert rating to construct the judgment matrix C for the project layer under the relevance indicators, as shown in Table 5.

Table 5: Project layer judgment matrix

C	C_1	C_2	C_3	C_4	C_5	C_6
C_1	1	3	2	1/4	6	5
C_2	1/3	1	1/2	1/4	5	3
C_3	1/2	2	1	1/5	5	4
C_4	4	4	5	1	6	2
C_5	1/6	1/5	1/5	1/6	1	7
C_6	1/5	1/3	1/4	1/2	1/7	1

The geometrical average method can be used to obtain the eigenvector of the judgment matrix C:
$V = (0.2461, 0.0925, 0.1647, 0.4293, 0.0516, 0.0158)^T$
The maximum eigenvalue $\lambda max = \sum_{i=1}^{n} \frac{(CV)_i}{nV_i} = 6.2964$. Then $CI = \frac{\lambda max - n}{n-1} = 0.05928$, according to data in Table 3, CI=0.05928<k_6=0.127, therefore, the judgment matrix C passes the consistency test, the weights of the project layer C1, C2, C3, C4, C5, and C6 under the relevance indicator were 0.2461, 0.0925, 0.1647, 0.4293, 0.0516, and 0.0158, respectively.
In addition, the same method is used to calculate the weights of the project layer under the reliability indicator, and a judgment matrix D is constructed, as shown in Table 6.

Table 6: Judgment matrix

D	C_8	C_9	C_{10}
C_8	1	1/4	1/3
C_9	4	1	2
C_{10}	3	1/2	1

The eigenvector of the judgment matrix D can be obtained by the geometric average method:
$V = (0.1469, 0.6178, 0.2353)^T$
The maximum eigenvalue $\lambda max = \sum_{i=1}^{n} \frac{(CV)_i}{nV_i} = 3.0275$. Then $CI = \frac{\lambda max - n}{n-1} = 0.01375$, according to data in Table 3, CI=0.01375<k_3=0.053, therefore, the judgment matrix D passes the consistency test, the weights of the project layer C8, C9 and C10 under the relevance indicator were 0.1469, 0.6178 and 0.2353, respectively.
3.2.6 Hierarchical total ranking of project layer of environment accounting information disclosure quality and the consistency test
Through the above analysis, the hierarchical total ranking can be obtained, as shown in Table 7.

Table 7: Table of hierarchical total ranking

Target layer	Index layer	Weight	Project layer	Weight	Total weight
A	B_1	0.6014	C_1	0.2461	0.1268
			C_2	0.0925	0.0513
			C_3	0.1647	0.0865
			C_4	0.4293	0.2397
			C_5	0.0516	0.0289
			C_6	0.0158	0.0176
	B_2	0.1324	C_7	1	0.1324
	B_3	0.2639	C_8	0.1469	0.0465
			C_9	0.6178	0.2004
			C_{10}	0.2353	0.0699

The consistency test uses the ratio of the total ranking consistency:
$CR = \frac{b_1 CI_1 + b_2 CI_2 + b_3 CI_3}{b_1 RI_1 + b_2 RI_2 + b_3 RI_3} = 0.0314 < 0.1.$

It passes the consistency test. The weights of the 10 indicators under the project layer are: 0.1268, 0.0513, 0.0865, 0.2397, 0.0289, 0.0176, 0.1324, 0.0465, 0.2004, and 0.0699. Among them, emissions of corporate pollutants and auditing of environment accounting information have higher weights

4. Conclusion

The environment accounting information disclosure in the chemical industry mainly includes text description and data description. At present, as a whole, the level of disclosure of environment accounting information of chemical companies is not high, and there is a large gap between the levels of disclosure of environment accounting information among different chemical companies.

This paper divides the 10 items of environment accounting information disclosure into three dimensions: relevance, saliency, and reliability, and establishes an evaluation system for accounting information disclosure quality of chemical companies. Through analysis, it is found that the importance of environment accounting information disclosure quality is: relevance, reliability, and saliency. In addition, out of the 10 indicators, corporate pollutant emissions and auditing of environment accounting information accounted for higher weights.

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