The Measurement of Shipping Enterprise Safety Culture Based on Fuzzy Comprehensive Evaluation Method

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Abstract

In order to further understand the safety culture of shipping companies, this paper adopts the method of fuzzy comprehensive evaluation to quantitatively measure the culture of shipping companies, so as to provide a reference direction for the implementation of safety culture of shipping companies, and also provide a method reference for the measurement of safety culture of shipping companies.

Keywords

Shipping Company; Safety Culture; Fuzzy Comprehensive Evaluation.

1.   The concept of safety culture

Safety culture stems from safety atmosphere. The Hawthorne experiment conducted by Mayo, a representative of the Group Behavior School of Management in 1924-1932, triggered a climax of research on organizational climate. In 1980, Zohar used and defined the safety atmosphere for the first time, and provided 8 dimensions of the safety atmosphere through investigation. With the continuous advancement of related research, a safety culture has emerged.

Safety culture was first proposed in the report of the 1986 Chernobyl nuclear power plant accident by the International Atomic Energy Agency. On this basis, the International Atomic Energy Agency held the "International Nuclear Energy Safety Conference-Future Strategy" in Vienna in 1991, and gave the definition of safety culture for the first time in the summary report entitled "Safety Culture" (INSAG-4). It is believed that safety culture is the sum of various characteristics and attitudes existing in units and individuals, and is a knowledge system that is reused to construct and understand normative behavior safety.

Although safety culture has been produced for a certain period of time, there is still no consensus on the specific meaning of safety culture. For example, in 1993, the British Health and Safety Commission also gave the definition of safety culture. It believed that safety culture is the product of the values, attitudes, concepts, abilities and behaviors of individuals and groups, and it determines the commitment to the safety and health management of the organization. And the style and proficiency of the organization. In view of the importance of safety culture to enterprise production safety, the State Administration of Work Safety has organized the drafting of AQ/T904-2008 enterprise safety culture construction guidelines, AQ/T905-2008 enterprise safety culture construction evaluation guidelines and other industry standards, and put enterprise safety Culture is defined as the unity of safety values, attitudes, ethics and behavioral norms shared by the employee groups of the enterprise organization. As the whole society attaches importance to safety culture and its important role in enterprises, safety culture has gradually become an important soft power for enterprises to participate in international competition, and its position in the construction of corporate culture has been continuously improved.

In recent years, safety culture has received extensive research attention, involving various aspects such as air traffic, nuclear safety, and hospital management. But relatively speaking, there are few researches on the safety culture of shipping companies. Based on this, this article will conduct an in-depth scientific research on the safety culture of shipping companies.

2.   Elements of safety culture of shipping companies

Based on the preliminary work and the opinions of experts in consultation, the safety culture of shipping companies can be evaluated by using the 10 main characteristics of the safety culture implemented by the company as an organization. The 10 characteristics are:

(1) The security policy and commitment of the enterprise decision-making management. Refers to the level of awareness of security at the top of the enterprise.

(2) Safety practices of enterprise decision-making management. Refers to the actual implementation level of security at the highest level of the enterprise.

(3) Awareness of employee safety identity. Refers to the degree of identity of safety awareness between employees on board and on board the company.

(4) The quality of the company's employees. Refers to the staff's working ability, team spirit, integration and collaboration and other methods.

(5) Attention to people. Refers to the extent to which management decision-making considers the impact of decision-making results on individuals in the enterprise organization.

(6) Reward and punishment system and safety guarantee control. Refers to the control method that motivates employees to implement safe behaviors and standardizes safety awareness.

(7) Corporate environment and daily operation management. The amount of work, the degree of standardization of daily management, working environment, etc.

(8) Corporate security activities. Safety knowledge and skills training, safety publicity, safety activities, etc. carried out by the enterprise.

(9) The openness of the system. Refers to the degree to which an enterprise grasps changes in the external environment and responds to these changes in a timely manner.

(10) Tolerance of conflict. Refers to the degree to which employees are encouraged to argue freely and criticize openly

3.   Basic principles and steps of AHP and fuzzy comprehensive evaluation

The AHP and fuzzy comprehensive evaluation model uses the analytic hierarchy process to calculate the weight coefficients of each index based on the establishment of an orderly hierarchical index system, and then integrates the influence of each factor on the evaluation object through the weighting method, and finally obtains a comprehensive evaluation of the evaluation object method.

Specific steps are as follows:

(1) Determine the factor set: Let $B=(B_1,B_2,\ldots\ldots, B_i)$ is an index set composed of an evaluation index.

(2) Determining the weight set: It is a set that indicates the importance of each indicator in the indicator system. Let $B_1=(b_1,b_2, \ldots\ldots, b_i)$ be a set of weights. $b_i \geq 0$, $i=1,2,\ldots$, m represents the weight of the ith index B_i in the index set.

The Analytic Hierarchy Process (AHP) is used to determine the weight of each indicator. That is to use the expert consultation method to construct the pairwise comparison judgment matrix, find the matrix eigenvectors and eigenroots , and conduct the consistency test to obtain the weight of each index.

(3) Suppose $V= (v_1, v_2,\ldots)$, v_i is a comment set, v_m $(m=1,2,\ldots\ldots,n)$ represents the comments at all levels from high to low, and the comments are divided according to experts' suggestions Set it to five levels: Very Good, Good, Fair, Poor, and Very Poor.

(4) The fuzzy relationship from B to V is described by the fuzzy evaluation matrix R:

$$R = \begin{bmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{bmatrix} \tag{1}$$

Among them, r_{ij} $(i=1,2,\ldots\ldots,m; j=1,2,\ldots\ldots,n)$ represents the membership degree of the J-th comment V_j of the i-th evaluation, and the value method of r_{ij} is The expert's scoring results are sorted out, and

we get Vi1 V1 comments, Vi2 v2 comments, …, vin vn comments for the i-th evaluation index, then for i=(1,2,…,m):

$$r_{ij} = \frac{v_{ij}}{\sum_{i=1}^{n} v_{ij}}, \quad (j=1,2, …,n) \tag{2}$$

Using the synthetic operation of the fuzzy matrix, the comprehensive evaluation model is obtained as P=B*R, where R=$(P_1 P_2 P_3 P_4 P_5)^T$

(5) Suppose the membership degree vector K=$(k_1, k_2, k_3, k_4, …, k_i)$ of the comprehensive evaluation result, and the midterm k_i is determined by using the median value of the percentile evaluation standard interval value.

(6) Use the product of the vectors to calculate the final evaluation result S, S is an algebraic value; S=$K_g P^T$

4. Establishment of a fuzzy comprehensive evaluation model for shipping enterprise safety culture

4.1 Determine evaluation factors

Select evaluation factors for the evaluation objects, and the evaluation factors are represented by B:
B = {$B_1, B_2, B_3, …, B_{10}$}

B_1: The security policy and commitment of the company's decision-making management;

B_2: The security practice of enterprise decision-making management;

B_3: Awareness of corporate employee safety identity;

B_4: The quality of the company's employees;

B_5: Attention to people;

B_6: Reward and punishment system and security assurance control;

B_7: Enterprise environment and daily operation management;

B_8: corporate security activities;

B_9: The openness of the system;

B_{10}: Conflict tolerance.

4.2 Select comment set

To evaluate the evaluation object, select the appropriate comment set V, and adopt international conventions. V = {AAA (very good), AA (good), A (fair), B (poor), C (very bad)}

4.3 Determine the weight

The factor weight reflects the internal relationship between the factors, and the weight reflects the importance of each factor in the overall factor. The weight vector is denoted as A = {$a_1, a_2, …, a_{10}$}. There are many methods for measuring weights. Such as AHP Delphi, scoring method, principal component analysis method, assignment method and so on.

4.4 Establish fuzzy relation matrix

According to the evaluation result of the evaluator on the evaluation object, the proportion of each comment level of each factor is calculated, and the fuzzy matrix R is obtained.

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ & \vdots & \ddots & \vdots \\ r_{101} & r_{102} & \cdots & r_{105} \end{bmatrix} \tag{3}$$

Among then, $\sum_{j=1}^{5} r_{ij} = 1 \quad (i =1, 2, 3, …, 10)$

4.5 Comprehensive fuzzy evaluation

According to the above weight vector A and fuzzy matrix R, the comprehensive evaluation matrix B can be determined by the following formula: B = A*R Considering the actual situation, a weighted average algorithm is used here.

4.6 Quantify and analyze evaluation results

First, normalize the comprehensive evaluation results

Secondly, in order to obtain an accurate evaluation result, the range of the variable value of each grade is set as: AAA (very good): 90~100, AA (good): 80~90, A (general): 70~80, B (Poor) 60~70, C(Poor): 0~60.

If the group median value is calculated, the rank evaluation matrix p is obtained: [95, 85, 75, 65, 30], the comprehensive evaluation quantitative value is: S = B * P. Then according to the size of S, find out the corresponding grade comment by referring to Table 1. This comment is the final evaluation result of a certain enterprise. Table 1 Evaluation result and comment level comparison rating comment AAA (very good) AA (good) A (fair) B (poor) C (very bad) Comprehensive evaluation value 90 ~ 100, 80 ~ 90, 70~ 80, 6 0 ~ 70,0 ~ 60.

5. Case analysis

According to the above method, give an example of fuzzy evaluation:

(1) Determining factor set: B={B_1, B_2, B_3, …, B_{10}}

(2) Determine the comment set: V = (AAA, AA, A, B, C)

(3) Determine the weight of the evaluation factors. Here, the Analytic Hierarchy Process (AHP) is used to measure the weight of each factor: A = (0.163, 0.125, 0.0148, 0.013, 0.014, 0.133, 0.104, 0.240, 0.08, 0.08)

(4) Establish fuzzy matrix

Such as inviting several experts to evaluate the safety culture of a shipping company. Summarize the forms filled out by experts, and write the frequency of people belonging to the 5 levels in the corresponding level column (see Table 2).

Table 2. The proportion of evaluation factors in the comment concentration

Evaluation factors	AAA(very good)	AA(good)	A(fair)	B(poor)	C(very bad)
Safety Policy and Commitment of Enterprise Decision Management	0.80	0.12	0.06	0.02	0
Safety Practice of Enterprise Decision Management	0.75	0.15	0.10	0	0
Awareness of corporate employee safety identity	0.65	0.10	0.20	0.05	0
Enterprise staff quality	0.60	0.20	0.10	0.10	0
Attention to people	0.70	0.15	0.05	0.05	0.05
Reward and punishment system and security control	0.80	0.20	0	0	0
Enterprise environment and schedule operation management	0.80	0.10	0.10	0	0
Corporate security activities	0.60	0.30	0.10	0	0
Openness of the system	0.75	0.05	0.05	0.10	0.05
Conflict tolerance	0.80	0.10	0.10	0	0

(5) Calculate the comprehensive evaluation result B = A*R, and then perform normalization S=90.931, and comparing Table 2 we know that this corporate culture belongs to a very good level.

6. Conclusion

Safety culture mainly uses the penetration and influence of safety culture to assist safety management. This article introduces the safety culture construction implementation model of the International Nuclear Safety Advisory Group, discusses and analyzes the safety culture measurement of shipping companies, and makes a quantitative analysis of this. Although an example is given to illustrate the evaluation method of the effectiveness of the safety culture construction of shipping companies, it is only an exploratory analysis. The ideas and methods in the article are worthy of further improvement by other experts and scholars.

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