Research on Safety Performance Appraisal Strength Based on Motivational Mechanisms

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Abstract. As a quantitative tool and implementation means, performance appraisal and motivational mechanisms play an important role in the enterprise safety management system. Taking the negative motivation strength as the research object, this paper established an evaluation method and calculation model of enterprise safety performance motivation. A comparative analysis of the safety performance motivation of four electric power enterprises and three industries was conducted to examine the evaluation method and calculation model. The results illustrated the characteristics of safety performance appraisal strength of those enterprises and industries. This study can further enhance the awareness of safety responsibility of all employees in enterprises, provide a reference for other industries to implement safety performance reward and punishment mechanism and a useful reference for enterprises to improve safety management.

1. Introduction

With the sustained development of the domestic economy and the continuous improvement of enterprise safety investment in recent years, the domestic production safety situation has shown a trend of improvement. However, there is still a large base of safety accidents and high severity of accidents now, and the safety situation is still not optimistic. Enterprise safety performance and motivational mechanisms are important means to effectively improve the level of safety management and contain production safety accidents. And their inadequate construction is one of the main reasons why the situation of enterprise safety production is not optimistic.

At present, many domestic scholars and institutions have carried out research on performance motivation. For example, Xie et al. discussed the role of reward and punishment mechanism in enterprise safety production management, and clarified the significance of motivation to safety work[1]. Duan discussed how to conduct a new safety evaluation and motivation system by establishing detailed evaluation indicators and motivation models[2]. Zhao explained the motivation strength of performance appraisal based on expectancy theory[3]. Generally speaking, safety motivation has become a core measure for contemporary enterprises to fully mobilize employees for safety production. In terms of safety production results, companies with better implementation of safety motivation will reduce the frequency and the severity of accidents.

However, most studies mainly focus on positive motivation, and there is almost no study on negative motivation. Therefore, this paper creatively took the negative motivation strength as the...
research object, and evaluated the punishment measures of responsible persons, departments and subsidiaries after accidents by comprehensively scoring the punishment strength of different enterprises and industries. This not only inversely enhances the crisis awareness of all employees, but also provides a basis for enterprises to establish reasonable appraisal tools of safety performance.

2. Appraisal method of safety motivation strength

Safety motivation refers to the management of safety production of enterprise organizations and individuals through expectancy theory, so as to achieve the purpose of improving the overall safety level of the enterprise. In the safety production, the establishment of motivational mechanisms for personnel and departments at all levels has become one of the most direct and effective methods of safety management[4]. As a connecting link in safety performance appraisal, safety motivation has the function of summarizing and evaluating the previous safety performance and guiding the goal setting of the next performance cycle[5]. As an important factor in the safety motivation, whether the safety motivation strength is in a reasonable range directly affects the effect of the safety motivation. Therefore, this section will introduce the theoretical basis and quantitative calculation principle for evaluating the strength of safety motivation.

2.1. Behavioral science motivation measurement

Expectancy theory, also known as Expectancy-Value Theory, was put forward by Victor H. Vroom, a famous psychologist and behavioral scientist in North America in 1964. It is one of the most influential theories in motivation theory. The equation can be expressed as:

\[ \text{Motivation} = \text{Valence} \times \text{Expectancy} \]  

Motivation refers to the intensity of mobilizing or stimulating the subject to give full play to his personal potential to complete a task[6]. Valence refers to the degree of personal preference to achieve a certain expected result, or the degree of satisfaction that a certain expected result may bring to an individual. Expectancy is the probability that a specific action can bring a certain expected result, that is, an individual takes a certain action to achieve a certain result, which leads to a possibility of psychological or physical satisfaction. Obviously, the motivation of an action that can meet a need to a particular individual is the result of a combination of the valence and the possibility of the result to be achieved.

2.2. Motivation strength of safety behavior

Based on the definition of motivation in management, the expectancy can be summarized as the level of expectation of different degrees of accidents in safety management which is called E. Valence means motivation measures in safety production, We call this factor V. Valence includes economic motivation and administrative motivation. Through the calculation of the assignment of these two factors, we can have a direct and clear understanding of the motivation strength of the enterprise.

\[ S_i = E \times V \]  

In the equation:

- \( S_i \)—Comprehensive index of accident accountability, which measures the comprehensive accountability of accident accountability systems in different enterprises.
- E—Expectancy. The level of expectation for accidents of varying degrees.
- V—Valence. That is, the strength of punishment, including economic punishment and administrative punishment.

Obviously, most enterprises have the coexistence of economic motivation and administrative motivation. In order to balance the impact of the two on \( S_i \), we introduce weights \( \gamma_1 \) and \( \gamma_2 \) to express the proportion of economic motivation (\( V_1 \)) and administrative motivation (\( V_2 \)) in the motivation for the same accident, respectively. Therefore, for the calculation equation of \( S_i \), we can further write as follows:
\[ S_i = E \times (V_1 \times \gamma_1 + V_2 \times \gamma_2) \] (3)

Among them, we set the expectancy in the equation to negative, and use the negative motivation means stipulated by the enterprise to integrate the weight when calculating the valence.

### 2.3. Safety expectancy (E) assignment

Appraisal indicators of enterprise safety performance are generally divided into three categories, namely source prevention appraisal indicators, process control appraisal indicators and result control appraisal indicators. At present, most enterprises take the accident levels in the result control (ordinary accident, large accident, major accident and extraordinarily serious accident) as the main reference factor for measuring safety motivation strength.

The survey found that the expectation level of enterprise personnel for safety accidents increases exponentially with the rise of the accident levels, which means their expectation level of extraordinarily serious accidents is much higher than that of major accidents. Therefore, this paper assigned values to all levels of production safety accidents based on the pyramid theory, as shown in Table 1.

| Accident level                      | Accident levels classification standard                        | Score |
|-------------------------------------|---------------------------------------------------------------|-------|
| Extraordinarily serious accident    | More than 30 deaths, or more than 100 serious injuries, or direct economic losses of more than 100 million yuan | 8     |
| Major accident                      | 10-30 deaths, or 50-100 serious injuries, or direct economic losses of 50 million-100 million yuan | 4     |
| Large accident                      | 3-10 deaths, or 10-50 serious injuries, or direct economic losses of 10 million-50 million yuan | 2     |
| Ordinary accident                   | Less than 3 deaths, or less than 10 serious injuries, or direct economic losses of less than 10 million yuan | 1     |

### 2.4. Safety valence (V) assignment

To make the final summary and comparative analysis more scientific and clear, a further quantitative analysis of the negative motivation after the accident is required after determining the level of the accident. In order to unify the process of negative motivation appraisal, this paper scored the degree of punishment measures of different enterprises in different industries. According to the strength of the punishment measures, the score from light to heavy is 1-10, with 1 representing the lightest punishment and 10 representing the heaviest punishment. The grading criteria are shown in Table 2.

| Form of accountability punishment | Punishment strength | Score |
|-----------------------------------|--------------------|-------|
| Economic punishment               | 10-20 thousand yuan| 3     |
|                                  | 20-40 thousand yuan| 5     |
|                                  | More than 40 thousand yuan| 7 |
|                                   | Warning             | 1     |
|                                   | Demerit             | 2     |
| Administrative punishment         | Major demerit       | 3     |
|                                   | Demotion            | 5     |
|                                   | Dismissal           | 7     |
|                                   | Fired               | 9     |

### 3. Empirical analysis on the motivation strength of safety performance

#### 3.1. Electric power enterprises

By analyzing the safety performance motivational mechanism documents of more than 20 enterprises in electric power, construction and metallurgy industries, this paper scores the economic and administrative punishment of four typical domestic electric power enterprises A, B, C and D. The data in Table 3 and Table 4 are obtained through the investigation of the motivation measures involved in
the internal performance implementation document of each enterprise, which ensure the authenticity and scientific nature of the data. The weights $\gamma_1$ and $\gamma_2$ are weighted averaged, and the average score is the safety valence. Finally, the safety expectancy ($E$) is multiplied by the safety valence ($V$) to get the safety performance motivation of A, B, C and D. The results are shown in Table 3.

Table 3. Statistics for safety performance motivation of electric power enterprises.

| Electric power industry | Punishment object | Ordinary accident | Large accident | Major accident | Extraordinarily serious accident |
|-------------------------|-------------------|-------------------|----------------|----------------|----------------------------------|
| The person primarily responsible for the accident | A | 4.75 | 11.00 | 32.00 | 68.00 |
|                       | B | 5.00 | 13.00 | 30.00 | 64.00 |
|                       | C | 5.00 | 11.00 | 32.00 | 68.00 |
|                       | D | 4.50 | 13.00 | 32.00 | 68.00 |
| Mean                   |    | 4.81 | 12.00 | 31.50 | 67.00 |
| The person secondarily responsible for the accident | A | 4.00 | 10.00 | 32.00 | 64.00 |
|                       | B | 4.00 | 11.00 | 30.00 | 60.00 |
|                       | C | 4.50 | 10.00 | 28.00 | 60.00 |
|                       | D | 4.50 | 11.00 | 30.00 | 68.00 |
| Mean                   |    | 4.25 | 10.50 | 30.00 | 63.00 |
| The accident department responsible person | A | 4.00 | 10.00 | 24.00 | 64.00 |
|                       | B | 3.50 | 12.00 | 26.00 | 60.00 |
|                       | C | 4.00 | 8.00  | 22.00 | 52.00 |
|                       | D | 3.50 | 10.00 | 26.00 | 64.00 |
| Mean                   |    | 3.75 | 10.00 | 24.50 | 60.00 |
| Primarily responsible person | A | 3.50 | 10.00 | 22.00 | 52.00 |
|                       | B | 3.50 | 11.00 | 28.00 | 64.00 |
|                       | C | 2.50 | 5.00  | 20.00 | 40.00 |
|                       | D | 3.00 | 8.00  | 22.00 | 44.00 |
| Mean                   |    | 3.13 | 8.50  | 23.00 | 50.00 |

According to Table 3, it can be seen that the motivation strength of electric power enterprise D is relatively large in the negative motivation to the person primarily responsible for the accident, the person secondarily responsible for the accident and the accident department responsible person. Among the negative motivation to the primarily responsible person, electric power enterprise B has the greatest motivation strength. Meanwhile, after the accident, the motivation strength of electric power industry to different responsible people is also different, from big to small in the following order: the person primarily responsible for the accident, the person secondarily responsible for the accident, the accident department responsible person, primarily responsible person. Moreover, for the same motivation object, the motivation strength of different enterprises for different levels of production safety accidents has been improved in different degrees. For example, for the person primarily responsible for the accident, the absolute difference from the ordinary accident to the large accident of the electric power enterprise B is higher than that of the electric power enterprise C, and the motivation level from the large accident to the extraordinarily serious accident is the same. Accordingly, we can know that the motivation strength of enterprise B to prevent the rise of ordinary accident level is higher than that of enterprise C.

By comparing the above calculation results, it can be found that electric power enterprises allocate corresponding motivation to different levels of safety managers, and the motivation for all levels of safety accidents are at a higher level. Combined with the industry characteristics of a wide range of electric power system and greater impact, the above comparative conclusions can reflect that the four electric power enterprises attach more importance to production safety and pay attention to prevention in advance. Based on this standard, other electric power enterprises can build safety performance motivational mechanisms suitable for the electric power industry and within the enterprise, so as to promote the safety production and future development of the enterprise.
3.2. Different industries
In order to provide better suggestions and ideas for the construction of safety performance motivational mechanisms for the electric power industry, this subsection selects the construction and metallurgical industry for data integration. Compared with the motivation strength of the electric power industry, the statistical results of the safety performance motivation in different industries are shown in Table 4.

Table 4. Statistics of safety performance motivation in different industries.

| Punishment object                        | Industry             | Safety performance motivation |
|------------------------------------------|----------------------|-------------------------------|
|                                          | Ordinary accident    | Large accident               | Major accident | Extraordinarily serious accident |
| The person primarily responsible for the accident | Electric power industry | 4.81                        | 12.00          | 31.50                          | 67.00          |
|                                          | Construction industry | 4.90                        | 14.00          | 36.00                          | 72.00          |
|                                          | Metallurgical industry| 4.92                        | 11.67          | 28.67                          | 64.00          |
| Primarily leader responsible person      | Electric power industry| 3.13                        | 8.50           | 23.00                          | 50.00          |
|                                          | Construction industry | 4.50                        | 14.00          | 34.00                          | 68.00          |
|                                          | Metallurgical industry| 4.53                        | 11.30          | 28.24                          | 63.15          |
| Production responsible person            | Electric power industry| 3.75                        | 10.00          | 24.50                          | 60.00          |
|                                          | Construction industry | 4.75                        | 14.50          | 35.00                          | 70.00          |
|                                          | Metallurgical industry| 4.17                        | 10.67          | 28.00                          | 62.67          |

It can be seen that in view of ordinary accidents and large accidents, the motivation strength of construction and metallurgical industry to different responsible persons is obviously higher than that of electric power industry. And for major accidents and extraordinarily serious accidents, although the motivation strength of the electric power industry is basically the same as that of the construction industry, it is also significantly lower than that of the metallurgical industry.

Generally speaking, compared with high-risk industries, the overall motivation strength of the electric power industry is relatively low. Therefore, the electric power industry should use this as a reference to increase the degree of economic and administrative punishment on different responsible persons after ordinary and large accidents, and improve the expectation level of accidents. To achieve the purpose of enhancing the crisis awareness of the electric power enterprises responsible persons, reducing the occurrence of safety accidents, and improving the overall safety level of the enterprise.

4. Conclusions
This paper first analyzes the current research status of performance appraisal and motivational mechanisms. Then, based on the motivation equation and related literature, the evaluation method and calculation model of enterprise safety motivation strength are established. What’s more, an empirical comparative analysis is carried out among electric power enterprises and different industries. The main conclusions are as follows:

1) When carrying on the safety performance appraisal to the enterprise, generally will construct the appraisal system from five aspects, its index involves all aspects. However, taking the result control appraisal indicators as the main reference factor can make the research on production safety performance appraisal more specific and targeted.

2) The safety motivation for different responsible persons after accidents in the electric power industry are relatively small. So the economic and administrative punishment for different responsible persons after accidents should be strengthened. In addition, we can also use the experience of the construction and metallurgical industry as a reference to increase the degree of economic and administrative punishment on different responsible persons after ordinary and large accidents.

3) Appropriate safety motivation measures should be taken on the basis of the classification of safety accident levels. It is necessary not only to implement a stricter punishment mechanism for those serious production accidents responsible persons, but also to set up a reward mechanism for sub-enterprises or responsible persons who have no accident. It can be said that this targeted safety reward and punishment mechanism is conducive to the overall design of the performance appraisal system,
which can not only ensure the sustainability of the safe behavior of enterprise leaders and employees, but also conducive to the long-term development of enterprise security.

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