Research on Construction of Safety Management System in State-owned Enterprises

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Abstract. The establishment of safety management system is of great significance to improve safety management of state-owned enterprises. In order to provide some help for state-owned enterprises to establish a safety management system, the shortcomings of state-owned enterprises in safety management are summarized and a general behavior paradigm of establishment of a safety management system from the enterprise level is put forward based on literature research. Besides, the key elements of safety management system are discussed by fuzzy Borda number analytical method based on the grille, and the results show that when setting up the key elements of the safety management system, enterprises should pay more attention to objectives and policies, risk control, emergency management, institutions and responsibilities, laws, regulations and standards, occupational health, performance evaluation, interested parties, check and correct, management review, education and training, on-site management, accident management, leadership and commitment, system support and continuous improvement.

1. Introduction

Production safety is not only the guarantee of people's lives and health, the basis for the survival and development of enterprises, but also a prerequisite for social stability[1]. At present, China is in the critical period of realizing the great rejuvenation. However, the situation of production safety is still grim and complicated. Some researchers believe that the root cause of accidents is lack of safety management system of the organization where the accidents occurred[2]. As the direct subject of the implementation of safe production, establishing an effective safety management system is the fundamental means for enterprises to prevent accidents. In the study of the establishment of safety management system, many scholars took a specific laboratory or a specific coal mine as the research object to establish a safety management system, whose focus were generally on the operation mechanism and content of the safety management system, rather than the construction process of the safety management system from scratch. Therefore, it is of little reference significance for enterprises to establish safety management system. In addition, some scholars hold the view that establishing and operating a safety management system in small and medium-sized enterprises is considered to be expensive but have no practical value to the organization, which makes it difficult for a formal structure such as a safety management system to maintain for a long time in the enterprise[3-4]. State-owned enterprises, usually large-scale and well-organized, are suitable for establishing a safety
management system[5]. Therefore, this article will put forward the general behavior paradigm of constructing the safety management system from the enterprise level and give some suggestions on setting elements from the system level, so as to provide some ideas and guidance for state-owned enterprises to establish a safety management system.

2. Analysis on the current situation of safety management in state-owned enterprises

The characteristics of state-owned enterprises are distinct, and so is their safety management. Through investigation and analysis of more than ten state-owned enterprises, the following deficiencies in safety management are summarized:

1) The production safety responsibility system is not complete, the internal dynamic mechanism of safety management is not sound. The implementation of the full member responsibility system is still in words, and the implementation of the principle of "the party and the government share the same responsibility, and the one post has double responsibility" lacks effectiveness.

2) Safety supervision personnel have more responsibilities than power, and safety supervision department is marginalized. There is a widespread phenomenon of staff and post redundancy in state-owned enterprises, but they are stretched in the allocation of safety supervision personnel, which can only meet the minimum standards required by the Production Safety Law of the People's Republic of China.

3) The correct concept of safety has not been deeply rooted in people's minds, and the "red line consciousness" of security has not been firmly established. The participation of safety activities among all employees is unsatisfactory. In practice, most employees believe that it is the responsibility of safety supervisors to ensure safety.

4) The safety management work is heavily documented. The predecessors of state-owned enterprises were generally subordinate to different government departments. After the separation of government and enterprise, although the name of the enterprise has changed, there is still a lot of inertia in the management system. The phenomenon of preventing accidents by meeting, documents and inspection has not been completely eradicated.

5) Emergency management needs to be strengthened. Under the background of emergency response plan scenario and legislative/institutional/regulatory systems (known in Chinese as "One Planning plus Three Systems"), majority of state-owned enterprises have established a basic emergency plan system, which lacks sufficient operability and practicability, however. There are also problems in the connection between the emergency preplan and the on-site disposal plan. Comprehensive emergency drill is inadequate; communication and coordination capabilities between departments cannot be tested effectively; and decisions such as emergency supplies reserve and call are made still based on empirical judgments.

3. Enterprises’ behavior in the process of establishing a safety management system

As mentioned in the previous chapter, the deficiencies in safety management of state-owned enterprises can only be completely solved by establishing a safety management system which advocates systematicness and continuous improvement, rather than taking stopgap measures. To establish a safety management system, the first job of an enterprise is to figure out what to do. By studying relevant literatures and considering the work characteristics of state-owned enterprises, a general paradigm of enterprises’ behavior for establishing a safety management system is proposed, as shown in Figure 1.
The preliminary preparation stage includes establishment of a working group, selection of a consulting firm, determination of working mechanisms and basic training. The basic training includes two aspects: basic theoretical research and training. Training is a long-term basic work, and there are three types of personnel to be trained: leaders, key members and ordinary employees, among which the most important one is the training for leaders. Generally, leaders are less involved in specific work in the process of system establishment, so it is necessary to train them at different stages to obtain support and recognition, so as to make the system establishment more smoothly.

The initial review stage includes sorting out the current safety work, process identification, hazard factor identification and risk appraisal. The current safety work refers to the current laws and regulations, industry standards, corporate rules, safety goals and completion status, performance of functional departments, and related resource allocation, etc. Process identification requires to fully identify activities and procedures within the enterprise and their interrelationships. Hazard factor identification and risk assessment is an important basic work for enterprises to establish safety management system.

The system planning stage includes system design, function assignment and system documentation. System design includes the design of file structure, framework and elements. Function assignment is to clarify the responsibilities and authorities of each department, which guarantees the normal operation of safety management system. System documentation means that the system is presented in
the form of official documents, following the principle of "the system does what the documents say, and the document records what the system does."

The system implementation stage includes preoperative preparation, trial operation, revision and improvement, formal operation, and certification. Preoperative preparation includes two aspects: publicity and trainings. The purpose of system trial operation is to test whether the system is mature and appropriate. During the trial operation, the requirements and provisions of the system should be implemented with as much as possible effort, without mandatory implementation, which are not necessarily enforced. The revision and improvement of the system requires that the problems found during the trial operation be solved systematically instead of just temporarily. After that, the safety management system will be officially operated. System certification is not a necessary step. Enterprises can decide whether to conduct system certification based on their own needs.

4. Key elements of the safety management system

4.1. Extraction of key elements

Setting key elements is the core part of establishing a safety management. This article selected 4 mature systems which are GB/T45001-2020 Occupational Health and Safety Management System, GB/T33000-2016 Basic norms of enterprise safety production standardization, Q/SY 1002.1-2003 Health, Safety and Environmental Management System, China Southern Power Grid Safety production risk management system. By understanding and integrating the names and corresponding contents of the first and second level elements of the 4 systems above, 26 key elements were obtained.

From three dimensions of advancement, suitability, and effectiveness, with the help of the fuzzy Borda number analytical method based on the grille, the weight size of the four systems' guiding significance for establishment of a safety management system for enterprise can be obtained[6]. Then, according to whether each element exists in the four systems (if it exists, the value is 1. otherwise, the value is 0), the final importance score of each element can be obtained by weighted summation.

The application process of fuzzy Borda number analytical method based on the grille is introduced as follows[7-8]:

1) Build a hierarchy. That is, a complicated problem is continuously decomposed until it can be evaluated with obvious indicators. Since the 4 systems in this article are indicators, there is no high hierarchy structure.

2) Set up a grille. Experts are invited to score each indicator under different attributes to obtain a complete grid.

3) Determine the degree of subjection. Suppose an expert scores the \(m\)-th attribute of the indicator \(C_p\) as \(B_m(C_p)\), among them: \(m=1,2,\ldots,M\), representing the \(m\)-th attribute; \(p=1,2,\ldots,N\), representing the \(p\)-th index. In the \(m\)-th attribute evaluation, calculate the subjection degree \(U_{mp}\) of each evaluated index \(C_p\) belonging to the "most important", among them: \(U_{mp} = B_m(C_p)\left(\max\left[B_m(C_p)\right]\right)^{-1}, (0 < U_{mp} < 1)\).

4) Calculate the fuzzy frequency of each index.

\[
f_{hp} = \sum_{m=1}^{M} \delta_m^h(C_p) U_{mp}
\]

\[
R_p = \sum_{h} f_{hp}
\]
In the above formula, \( f_{hp} \) is the fuzzy frequency; \( R_p \) is the fuzzy frequency sum of the indicator \( C_p \); \( \delta^h_m(C_p) \) is the priority of each indicator.

Define \( \delta^h_m(C_p) \) as follows: Sort the \( m \)-th attribute of the index to get the priority relationship, if the index \( C_p \) ranks \( h \) in this priority relationship, \( \delta^h_m(C_p) = 1 \); otherwise \( \delta^h_m(C_p) = 0 \). When the index \( C_i \) and the index \( C_j \) have the same ranking in this priority relationship and are tied as \( h \), \( \delta^h_m(C_i) = \delta^h_m(C_j) = \frac{1}{2} \); in the same way, if the three indexes \( C_i, C_j, \) and \( C_k \) rank \( h \) in the priority relationship of the \( m \)-th attribute, \( \delta^h_m(C_i) = \delta^h_m(C_j) = \delta^h_m(C_k) = \frac{1}{3} \), so on and so forth.

5) Calculate the fuzzy Borda number \( FB(C_p) \). Define \( Q_h = \frac{1}{2}(N-h)(N-h+1) \), which represents the weight of each index \( C_p \) when ranked \( h \) in the priority relationship. From this, the calculation formula of the fuzzy Borda number \( FB(C_p) \) can be derived as follows:

\[
FB(C_p) = \sum_{h} \frac{f_{hp}}{R_p}Q_h = W_{hp}Q_h
\]

\[
W_{hp} = \frac{f_{hp}}{R_p}
\]

6) Normalization. The fuzzy Borda number \( FB(C_p) \) of each index is normalized to obtain the weight value of each index:

\[
W_p = \frac{FB(C_p)}{\sum_{p=1}^{N} FB(C_p)}
\]

According to the calculation process above, the weight of the guiding significance of the four systems to establishment of a safety management system for state-owned enterprises and the final scores of the 26 elements can be obtained, as shown in Table 1 and Table 2 respectively.

| Safety management systems                                           | Weights |
|-------------------------------------------------------------------|---------|
| GB/T45001-2020 Occupational Health and Safety Management System  | 0.2755  |
| GB/T33000-2016 Basic norms of enterprise safety production standardization | 0.1186  |
| Q/SY 1002.1-2003 Health, Safety and Environmental Management System | 0.2165  |
| China Southern Power Grid Safety production risk management system | 0.3894  |
Table 2. Score of the key elements in safety management system.

| Elements                                      | Score  |
|----------------------------------------------|--------|
| Objectives and policies                      | 1.0000 |
| Risk control                                 | 1.0000 |
| Emergency management                         | 1.0000 |
| Institutions and responsibilities            | 0.7245 |
| Laws, regulations and standards              | 0.7245 |
| Occupational health                          | 0.7245 |
| Performance evaluation                       | 0.6106 |
| Interested parties                           | 0.6059 |
| Check and correct                            | 0.6059 |
| Management review                            | 0.6059 |
| Education and training                       | 0.5080 |
| On-site management                           | 0.5080 |
| Accident management                          | 0.5080 |
| Leadership and commitment                    | 0.4920 |
| System support                               | 0.4920 |
| Continuous improvement                       | 0.4920 |
| Personnel participation                      | 0.3941 |
| Safety technology                            | 0.3894 |
| Tools and equipment                          | 0.3894 |
| Safety information technology                | 0.2165 |
| Investigation and treatment of hidden dangers | 0.2165 |
| Work permit                                  | 0.2165 |
| Cleaner production                           | 0.2165 |
| Change management                            | 0.2165 |
| Safety input                                 | 0.1186 |
| Safety culture                               | 0.1186 |

4.2. Some suggestions

With the results shown in Table 3, some suggestions can be made:

1) For an element with a score greater than 0.7, it must be maintained by an enterprise when establishing a safety management system.

2) For an element with a score of 0.4 to 0.7, it is appropriate for an enterprise to consider it as a framework element when establishing a safety management system.

3) For an element with a score less than 0.4, the enterprise should decide based on its own reality to retain it or incorporate it into other framework elements as one aspect of safety management, when establishing a safety management system. Taking safety culture as an example, it is generally considered by society to achieve "initiative safety" with cultural influence as the most brilliant means[9]. Therefore, the low score of safety culture in this article does not mean that it is unimportant enough to be ignored, but the scientific thinking of "culture prospers safety" always penetrates into safety goals, leadership and commitment, education and training, etc. That is, safety culture is not suitable to be a framework element of a safety management system.

5. Conclusions

In general, this article discusses some aspects of establishing a safety management system in state-owned enterprises, which are summarized as follows:

1) It summarizes the deficiencies of state-owned enterprises in safety management, which mainly are imperfect accountability system, marginalization of safety supervision departments, weak awareness of safety of all employees, serious safety work documents, and imperfect emergency response systems. It is conducive to providing problem orientation for enterprises to establish safety management system.
2) From the enterprise level, it puts forward a behavior paradigm which should provide some guidance for the establishment of a safety management system for enterprises on a macro level.

3) The safety management elements corresponding to the common problems of state-owned enterprises appear in the forefront of Table 3. Therefore, it can be concluded that when setting up the key elements of the safety management system, enterprises should pay more attention to objectives and policies, risk control, emergency management, institutions and responsibilities, laws, regulations and standards, occupational health, performance evaluation, interested parties, check and correct, management review, education and training, on-site management, accident management, leadership and commitment, system support and continuous improvement.

Acknowledgments
This research was funded by Science and Technology Project of State Grid Corporation of China, grant number WBS: 1400-201957282A-0-0-00. The project’s title is Research on the construction of state grid security management system.

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