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Coal Mine Technology Management and Its Importance Analysis

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Abstract*:* In order to strengthen the technical management level of coal mines, on the basis of the review of the prior art management, combined with the main content and responsibilities of the coal mine enterprise's own technical management system, the concept of coal mine technology management was defined, and the importance analysis of each index was carried out by using grey correlation analysis. The research results show that the impact of various indicators on safety performance in coal mine technology management is from: large to small: equipment maintenance and renewal costs, number of new technology introduction and application, number of safety (technical) management, number of safety training, number of optimized systems, engineering Reserve fee. Through the research of this paper, it provides a corresponding reference for the technical management of coal mines.

Keywords Coal mine; Technology management; Importance analysis; Safety performance

INTRODUCTION

With the rapid development of social science and technology, the coal mine technology has brought about more and more progress, and the safe production of coal mine enterprises requires each mine to achieve better utilization of production and management technologies [Wang, 2010, Zhang et al., 2014]. In recent years, with the increase in the depth and strength of coal mining, major accidents in coal mines have occurred from time to time [Wang et al., 2018]. Due to the poor management of coal mine technology, it is extremely important to strengthen the technical management of coal mines. Based on the summary of prior art management, combined with the main content and responsibilities of coal mine enterprise's own technical management system, this paper gives the concept of coal mine technology management, and uses gray correlation analysis to analyze the importance of each index.

COAL MINE TECHNOLOGY MANAGEMENT DEFINITION

Technology management is a complex and comprehensive management activity, focusing on the development and implementation of technology, and the process of technology diffusion to industry and government [Chu., 1997].

Coal mine production technology activities and safety technology activities include: geology and measurement, capital construction, technological transformation, development and deepening, coal mining methods and mechanization, roadway excavation and mechanization, mining under special conditions, ventilation safety and labor protection, electromechanical equipment and maintenance, coal deep processing and environmental protection, quality standardization, etc. Coal mine technology management is to manage and coordinate the above activities, and also need to plan, organize, analyze and make decisions about their technology development and innovation [Song et al., 2009]. In view of this definition, mine technology management is the management of the production technology activities, safety technology activities and technological innovation of coal mining enterprises, for organizing, coordinating, coordinating and planning the people, things and environment of coal mining enterprises in the production process rational allocation and efficient use of resources.

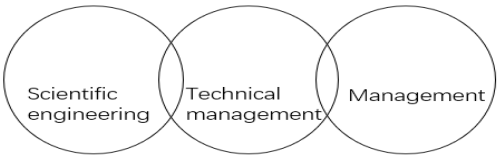

Figure 1. The status of technology management

Here, we set up a scientific and reasonable technical management model "TM" technology management mode, starting from the combination of upgrading technology and improving management to promote technology management and eliminate accidents. The mining area technology (T) includes:

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technological innovation, planning control, and information technology application; improving safety management (M) includes: technology introduction and update management, rational allocation management and education and training management.

In the "TM" technology management model: T-Technology, updating mine technology; M-Management, improving safety management.

The meaning of the technical management mode is: to promote the improvement of coal mine safety management with strict, reliable and reasonable technology; at the same time, to strengthen the technical strength of coal mines with strict, efficient and specific management. With the joint promotion of technology and management double locks, the safety of coal mines will be improved. Its mode is shown in Figure 2.

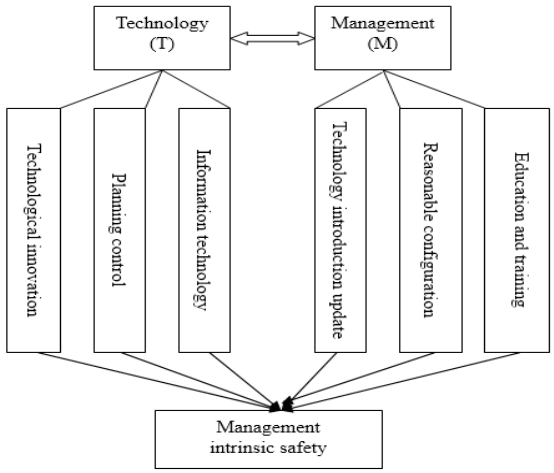

Figure 2. Sketch map of the "TM" technology management mode

In order to improve the intrinsic safety of the mine as the ultimate goal, the common technical management indicators were selected and summarized: equipment maintenance and renewal costs, safety (technical) management, new technology introduction and application, engineering preparation fee, optimization system number, safety number of trainings.

Equipment is the basis for ensuring the operation of the entire mining area. The investment in maintenance and renewal of various equipment, facilities, instruments, etc. also reflects the support of technical forces and is the basis for equipment safety; the increase in the number of safety management and the increase in the number of safety training It can promote the improvement of staff skills and improve the quality. It is the basis for personnel safety; the allocation of engineering reserve fees, the introduction of new technologies and the optimization of the system are all for the improvement of the safety management of the entire mining area and the safety of the "ring".

TECHNICAL MANAGEMENT INDEX RANKING

Safety performance is a direct manifestation of safety management effects [Huang, 1996]. Since casualties and equipment damage are the most direct manifestation of the consequences of accidents, the reciprocal of the number of casualties and the reciprocal of the number of equipment losses are selected as indicators for evaluating safety performance. The analytic hierarchy process determines their weights and uses the weighted average method to calculate safety performance. The calculation method is as follows:

$$P_i = K_1 B_{1i} + K_2 B_{2i} \quad (1)$$

Where, P_i is the safety performance of the i-year. K_1 is the weight of indicator 1 (the reciprocal of the 1,000 casualties). B_{1i} is the value of indicator 1 of the i-year (the reciprocal of the death rate of thousands). K_2 is the weight of indicator 2 (the reciprocal of the number of equipment lost). B_{2i} is the value of indicator 2 of the i-year (the reciprocal of the number of equipment lost).

And calculated by the analytic hierarchy process, the weights of indicator 1 and indicator 2 are: 0.9 and 0.1.

INSTANCE CALCULATION

Take the Yangchangwan Mine as an example to calculate the importance of its coal mine technical indicators. Yangchangwan Mine is the main production mine of Shenhua Ningmei Group. It is the first large-scale modern mine developed and built by Ningdong University. Since the reorganization in 2006, the mine has taken on the effect of Ningdongda's "experimental field" in the construction and development. Firstly, the fully mechanized fully mechanized caving technology experiment, especially the 6.2 m large mining height excavation technology, has greatly improved. The mine excavated production capacity and invented a new record for coal mining, daily production and monthly production in Ningxia. Currently, mine capacity is stable at 15 million tons/year.

According to the actual situation of Yangchangwan Coal Mine from 2012 to 2014, the safety performance of each year is calculated from the above formula, and then the weight of each indicator is determined. The data statistics of the indicators in the technical management of Yangchangwan Coal Mine from 2005 to 2007 are shown in Table 1 and 2. Gray correlation analysis of technical management and safety performance was performed by grey correlation analysis method according to the data shown in the table.

Table 1. The safety performance of Yangchangwan Coal Mine in 2005~2007 years

Indicator year	2012	2013	2014
1/1000 casualty rate	0.210	0.231	0.198
1/Number of equipment losses	0.070	0.067	0.060
Safety performance	0.205	0.235	0.216

Table 2. The statistical data of Yangchangwan Coal Mine's technology management index in 2005~2007 years

Indicator	2012	2013	2014
Equipment maintenance update fee (ten thousand yuan)	284	290	350
Safety (technical) management	52	52	54
Number of new technology introduction applications	3	4	6
Project preparation fee (ten thousand yuan)	673	650	840
Optimize the number of systems	3	5	3
Number of safety training	156	160	180

(1) Determine the reference sequence and compare the series

Taking the safety performance of the last three years (2012~2014) as a reference series X_0, then

X_0= (0.205, 0.235, 0.216).

In the last three years (2012~2014): equipment maintenance update fee (ten thousand yuan), safety (technical) management number, new technology introduction and application number, project preparation fee, optimization system number, safety training number as a comparison sequence X_1, X_2, X_3, X_4, X_5, X_6, then:

$$X_1 = (284, 290, 3350),$$

$$X_2 = (52, 52, 54),$$

$$X_3 = (3, 4, 6),$$

$$X_4 = (673, 650, 840),$$

$$X_5 = (3, 5, 3),$$

$$X_6 = (156, 160, 180).$$

(2) Data preprocessing

The data of Table 2 is preprocessed by Equation 2, and the data after preprocessing is shown in Table 3.

$$\begin{cases} X_i^{/} = \left(\dfrac{x_i(1)}{\bar{x}_i}, \dfrac{x_i(2)}{\bar{x}_i}, \dfrac{x_i(3)}{\bar{x}_i}, \Lambda, \dfrac{x_i(n)}{\bar{x}_i} \right) \\ \bar{x}_i = \dfrac{1}{n} \sum_{j=1}^{n} x_0(j) \end{cases} \quad (2)$$

Table 3. The results of data processing

X'_0	X'_1	X'_2	X'_3	X'_4	X'_5	X'_6
0.792	0.770	0.880	1.096	0.588	0.910	1.333
1.012	0.580	1.100	0.677	0.980	0.696	0.966
0.850	0.820	0.950	1.106	0.900	0.696	1.000

(3) Calculate the difference between the comparison sequence and the reference sequence

After the data matrix is preprocessed, it is calculated according to the formula (3).

$$\Delta_i(j) = \left| X_i^{/}(j) - X_0^{/}(j) \right| \quad (3)$$

Where i=1,2,……; j=1,2,……

From this formula, the difference matrix can be obtained, as shown in Table 4, and then the two-level maximum difference and the two-level minimum difference in the contact relationship are obtained.

Table 4. The difference matrix

j	Δ_{1j}	Δ_{2j}	Δ_{3j}	Δ_{4j}	Δ_{5j}	Δ_{6j}
1	0.573	0.077	0.408	0.329	0.172	0.333
2	0.927	0.036	0.301	0.500	0.314	0.163
3	0.482	0.102	0.249	0.396	0.255	0.245

(4) Calculate the correlation coefficient

It is known from the difference matrix and the two-stage maximum difference and the two-level minimum difference formula 4 that Δmax=1.693, Δmin=0.0010.

$$\begin{cases} \Delta \max = \max\limits_i \max\limits_j \left| x_i^{/}(j) - x_0^{/}(j) \right| \\ \Delta \min = \min\limits_i \min\limits_j \left| x_j^{/}(j) - x_0^{/}(j) \right| \end{cases} \quad (4)$$

Thus, the correlation coefficient matrix can be calculated according to the correlation coefficient formula 5, as shown in Table 5.

$$r_{ij} = \frac{\Delta \min + \alpha \Delta \max}{\Delta_{ij} + \alpha \Delta \max} \quad (5)$$

Table 5. The correlation coefficient matrix

r_{1j}	r_{2j}	r_{3j}	r_{4j}	r_{5j}	r_{6j}
0.444	0.760	0.712	0.990	0.773	0.667
0.752	0.696	0.963	0.954	0.753	0.820
0.685	0.695	0.983	0.933	0.664	0.827

(5) Calculating the degree of relevance

$$R_i = \frac{1}{n} \sum_{j=1}^{n} r_{ij} \quad (6)$$

It can be obtained from Equation 6 and the correlation coefficient matrix:

R_1=0.855, R_2=0.750, R_3=0.785,

R_4=0.676, R_5=0.700, R_6=0.723.

RESULTS AND DISCUSSION

From the correlation degree obtained above, it is known that X_1>X_3>X_2>X_6>X_5>X_4. And the degree of influence of various indicators in the technical management on safety performance is as follows: equipment maintenance and renewal costs, number of new technology introduction applications, number of security (technical) management, number of security training, number of optimized systems, and engineering reserve fees.

CONCLUSION

(1) During the technical management process of the mine, it is necessary to pay attention to the maintenance of the equipment renewal. In the normal production period of the mine, ensuring the safe and normal operation of the facilities and equipment is the premise of safety guarantee; the increase of the number of safety management can make the safety management The work is further refined, the safety management work is more specific, each has its own duties, and the code is efficient; the increase in the number of safety training can enhance the safety awareness of employees and enhance the safety culture of the entire mining area; optimizing the system can make the production more Efficient, reducing the number of underground workers, the system operation is more efficient; the setting of the engineering reserve fee is related to the emergency response of the mining area and the allocation of production resources.

(2) In the process of mine safety management, special attention should be paid to the maintenance and replacement of equipment, which is the top priority of technology management; secondly, the introduction of professional talents in mining, especially the introduction of safety management talents; It is possible to optimize the various systems and subsystems of the mine; and there must be sufficient engineering preparation fees.

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