

Study on the Influence of Safety Culture Level on The Unsafe Behavior of Coal Miners

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Abstract: In order to explore the influence of safety culture level on the unsafe behavior of coal miners, the structural equation model method is used to study. Summary combing the internal and external research results, put forward the measure of safety culture level of safety atmosphere, safety attitude, safety awareness, safety training four influencing factors, construct structure equation model, proposed model analysis hypothesis, the introduction of unsafe psychology as a intermediary variable, according to Henan, Shanxi coal mine 226 effective sample data, using AMOS software verification analysis. The results show that the safety atmosphere, safety attitude, safety awareness and safety training all have negative effects on the unsafe behaviors, and the unsafe psychology is positively related to the unsafe behaviors. According to the results of the model analysis, the corresponding intervention countermeasures will have a positive effect on preventing accidents in coal mine.

Keywords: Safety culture level; Unsafe behavior; Structural equation model; Coal miners.

1. Xu Theory

In recent years, safety accidents occur frequently in coal mine enterprises, and the problem of coal mine safety production has become the primary problem to solve. Due to the complex underground environment, narrow working space of workers, poor working conditions, improper organization and management and other factors, although the safety situation has been greatly improved, but safety accidents still occur from time to time. Through a large number of accident investigation, statistical analysis and research, it shows that the unsafe behavior of coal miners is the main cause of frequent coal mine accidents. More than 90% of coal mine accidents are caused to accidents[1], The unsafe behavior of people directly or indirectly affects the occurrence of accidents[2]. Therefore, in order to reduce the occurrence of coal mine accidents, it is necessary to maximize the people to eliminate the unsafe behavior.

People's unsafe behavior is affected in many ways. Choudhry et al. analyzed the influencing factors of unsafe behavior and concluded that factors such as personal characteristics, work pressure and safety atmosphere have an important influence on unsafe behavior[3]. Naves tad The research on unsafe behavior shows that safety culture has an impact on unsafe behavior[4]. Li Jizu and others analyzed the relationship between the psychological factors of coal mine workers and production safety, and constructed the psychological evaluation system of coal mine workers[5]. Huang Wei et al. studied the causes of coal mine accidents in China by using the theory of accident cause, and found that the psychological factors of miners are the main influencing factors of unsafe behaviors of miners[6]. Jiang Qinyao et al. used the explanatory structure model (Interpretive Structural Modeling, ISM) to study the unsafe behavior of workers, and the study believed that safety awareness affects the unsafe behavior[2]. Li Huawei and Zhou Lixin pointed out that the unsafe behaviors of employees can be suppressed by strengthening the safety training, improving the production environment and strengthening the care of employees[7]. Xu Guofeng collected data from 122 miners by questionnaire

survey and analyzed data by structural equation model, and concluded that safe atmosphere is the main factor of unsafe behavior[8]. Sun Jian, Zhang Boyang et al. used structural equation model and hierarchical regression model to analyze the internal and external causes of unsafe behaviors of construction workers, which provides a theoretical basis for avoiding the occurrence of unsafe behaviors[9].

Safety culture was first proposed in the 1980s by the nuclear organization Safety Research Association. They believed that "the safety culture of a unit is a comprehensive product of individual and collective values, attitudes, ideas, abilities, and behaviors, which determines the commitment, work style and proficiency of safety management". Fu Gui et al. analyzed the cultural construction level of the 60 coal mining enterprises in China, and concluded that the coal mining enterprises should improve the safety culture training system in time[10]. Luo Chuanlong and Hu Yanmei confirmed the decisive role and influence trend of safety culture by using the field investigation, analysis, induction, summary and the quantitative measurement system of safety culture on safety performance[11]. Zhao Pengfei and He Ahong made a fuzzy comprehensive evaluation of the safety culture level of coal mining enterprises, and the results show that the level of safety culture is closely related to the safety level and safety performance of enterprises[12]. Guo Renlin used the gray fuzzy evaluation method to obtain the comprehensive evaluation value of the safety culture of coal mining enterprises, and put forward some suggestions[13]. Tian Shuicheng and Ding Yang established the dynamic model of the miners' unsafe behavior system, and concluded that the safety rules and regulations, safety education and training, and safety culture have a great influence on the unsafe behavior of the coal mine workers[14].

To sum up, China pays more and more attention to the research of unsafe behavior in coal miners, but the research on safety culture level is not perfect. Therefore, it is necessary to study the influence of safety culture level on the unsafe behavior of coal miners, and it has a positive impact on reducing the occurrence of coal mine safety accidents.

2. Model Building

Structural equation model allows factor analysis and path analysis of factor interaction within complex system. This paper discusses the influence of safety culture level on unsafe behavior, most of the selected indicators are not directly observed variables, and the structure equation model to make up for this defect, it can be observed by the latent variables, so this paper adopts structural equation model for the safety culture level of unsafe behavior.

2.1. Safety culture level

The level of safety culture is only the common values, beliefs, attitudes and behaviors of safety within the organization, which reflects the importance of safety and the effectiveness of safety management. There is a close relationship between safety culture level and unsafe behavior. First of all, organizations with a high level of safety culture usually have a strong safety awareness, employees have a high degree of understanding of safety issues, and can consciously abide by safety regulations and operating procedures, so as to reduce the occurrence of unsafe behaviors. Secondly, organizations with a high level of safety culture will usually resume a perfect safety management system and reward and punishment system to reward safety behaviors and punish unsafe behaviors, so as to strengthen the safety awareness of employees and improve the level of safety culture.

2.2. The study hypothesis

Since the level of safety culture cannot be directly measured, the level of safety culture is divided into four dimensions: safety atmosphere, safety awareness, safety attitude and safety training. However, the mechanism of safety culture level on effect of unsafe behavior cannot be comprehensively expounded only by studying four dimensions. Due to the harsh working environment in the coal mine, the coal miners are in a dark and humid environment for a long time, the daily working intensity is large, the working hours are long, and the influence of noise makes the coal miners are in a state of exhaustion, easy to produce unsafe psychology. Therefore, this paper takes the unsafe psychology as a medium variable to study the influence of safety culture level on unsafe behavior.

Through the statistical analysis of the safety culture level, the following assumptions are proposed:

H1 Safety atmosphere is negatively associated with the unsafe behavior of coal miners;

H2 Safety attitude is negatively associated with the unsafe behavior of coal miners;

H3 Safety awareness is negatively correlated with the unsafe behavior of coal miners;

H4 Safety training is negatively associated with the unsafe behavior of coal miners;

H5 Safety atmosphere is negatively associated with unsafe psychology;

H6 Safety attitude is negatively associated with unsafe psychology;

H7 Safety awareness is inversely associated with unsafe psychology;

H8 Safety training is negatively associated with unsafe psychology;

H9 Unsafe psychology is positively correlated with the unsafe behavior of coal miners;

H10 The safety atmosphere is positively correlated with the safety attitude;

H11 Safety atmosphere is positively correlated with safety awareness;

H12 Safety atmosphere is positively correlated with safety training;

H13 Safety attitude is positively correlated with safety awareness;

H14 Safety attitude is positively correlated with safety training;

H15 Safety awareness is positively correlated with safety training.

2.3. Model construction

Structural equation model (Structural Equation Modeling, SEM) is a statistical analysis method, mainly used to study the relationship between variables, and can also be used to verify and modify theoretical models. Structural equation models mainly include dominant variables and latent variables, endogenous variables and exogenous variables, error variables, etc., which can analyze a variety of complex relationships between variables, including causality, mediation effect, and regulatory effect. Based on the 15 assumptions proposed in this paper, the AMOS software builds the structural equation model of coal workers' safety culture level for the unsafe behavior, the safety atmosphere, safety attitude, safety awareness, safety training, unsafe psychology and unsafe behavior are latent variables, and the observation variables are expressed by rectangle, and the circle represents the residual items.

3. Empirical Analysis

3.1. Questionnaire design

On the basis of the level of coal mine safety culture and the measurement index of unsafe behavior, the scale developed by Li Naiwen, B ARLING, Liu Jialong and Yao Youli was designed to be easy to understand. The questionnaire is divided into three parts: (1) questionnaire description; (2) basic information of coal miners, including age, gender, length of service, educational background, marriage, etc.; (3) safety atmosphere, safety attitude, safety awareness, safety training, unsafe psychology, and unsafe behavior scale. The questionnaire was prepared using the Likert 5-point method, using the 5-level scoring criteria.

3.2. Basic information of the questionnaire survey

In this study, workers worked for a long time underground in two coal mines in Henan and Shanxi. A total of 260 questionnaires were distributed and 242 were recovered, with a recovery rate of 93.07%. Among the collected questionnaires, 16 invalid questionnaires were removed and 226 valid questionnaires were removed, with an effective rate of 93.39%. Among the respondents, men accounted for 97.79%, married 96.02%, the number of people between 31 and 40 was the most, accounting for 55.75%, the number of people in high school or technical secondary school was the largest, accounting for 44.69%, and the number of people between 6 and 10 years was the most, accounting for 37.61%.

3.3. Credit and validity analysis

By performing reliability analysis using the clonal Bach coefficient Cronbach's α , Cronbach's α values are between 0

and 1, with larger values indicating higher confidence..7 In general, Cronbach's α values greater than 0 indicate that the questionnaire is acceptable. SPSS 24.0 software is used to analyze the data of safety culture level, unsafe psychology and unsafe behavior scale. It can be seen from the results that

the overall reliability coefficient of each dimension and scale is greater than 0, indicating that the questionnaire survey has good reliability. The overall reliability coefficients of each dimension and scale are shown in Table 1.

Table 1. Overall reliability coefficients for each dimension and scale

Scale and dimension	Cronbach's α	Overall scale
Safety culture level	Security atmosphere	0.899
	Safety attitude	0.893
	safety consciousness	0.810
	safety training	0.865
Unsafe psychology		0.865
unsafe act		0.931

3.4. Validity analysis

The validity test is to test the validity of the questionnaire..7.000 In this paper, SPSS 24.0 was used to analyze the data, and concluded that the KMO values of 6 variables were greater than 0, and the P value of Bartlett's spherical test was 0, indicating that the questionnaire is

suitable for factor analysis, and the factor load of each variable exceeded 0, so the questionnaire has high reliability. The specific measures of each variable are shown in Table 2..5(Among them, AF represents safety atmosphere, AT represents safety attitude, AY represents safety awareness, AP represents safety training, AX represents unsafe psychology, and BX represents unsafe behavior)

Table 2. The specific measurement indicators for each variable

variable	Question item	Factor load	KMO
Security atmosphere (AF)	AF1	0.770	0.911
	A F2	0.776	
	A F3	0.791	
	A F4	0.770	
	A F5	0.775	
	A F6	0.740	
Safety attitude (AT)	A T1	0.836	0.888
	AT2	0.771	
	A T3	0.794	
	A T4	0.804	
	A T5	0.747	
safety consciousness (AY)	A Y1	0.779	0.800
	A Y2	0.753	
	A Y3	0.741	
safety training (AP)	A Y4	0.689	0.713
	A P1	0.827	
	A P2	0.833	
Unsafe psychology (AX)	A P3	0.792	0.825
	A X1	0.721	
	A X2	0.722	
	A X3	0.686	
	A X4	0.722	
	B X1	0.758	
unsafe act (BX)	B X2	0.740	0.928
	B X3	0.751	
	B X4	0.750	
	B X5	0.726	
	B X6	0.733	

3.5. Model test of the structural equations

After passing the reliability and validity test, the AMOS is used to verify the proposed hypothesis relationship. The path coefficient and regression results between the variables

obtained after calculation are shown in Table 3. Except for hypothesis H 6: the safety attitude to unsafe psychology and H7 safety awareness to unsafe behavior, the remaining 13 assumptions are valid.

Table 3. Results of the pathway regression coefficient

way	Estimate	C.R.	P price	conspicuousness
H1	-0.188	-2.736	***	notable
H2	0.019	2.208	***	notable
H3	0.101	2.778	***	notable
H4	-0.139	-3.41	***	notable
H5	-0.015	-4.153	***	notable
H6	-0.216	-1.588	0.01	quiet
H7	-0.225	-1.901	0.057	quiet
H8	-0.11	-2.236	***	notable
H9	0.791	9.08	***	notable
H10	0.385	5.801	***	notable
H11	0.343	5.522	***	notable
H12	0.276	4.796	***	notable
H13	0.362	6.043	***	notable
H14	0.253	4.333	***	notable
H15	0.334	4.978	***	notable

Combined with the actual situation of coal miners, after calculation, the model calculates the fit of each index is in a reasonable range, so the model has a high degree of fit.

Through analysis, the model is determined to be acceptable, and the model diagram obtained is shown in Figure 1.

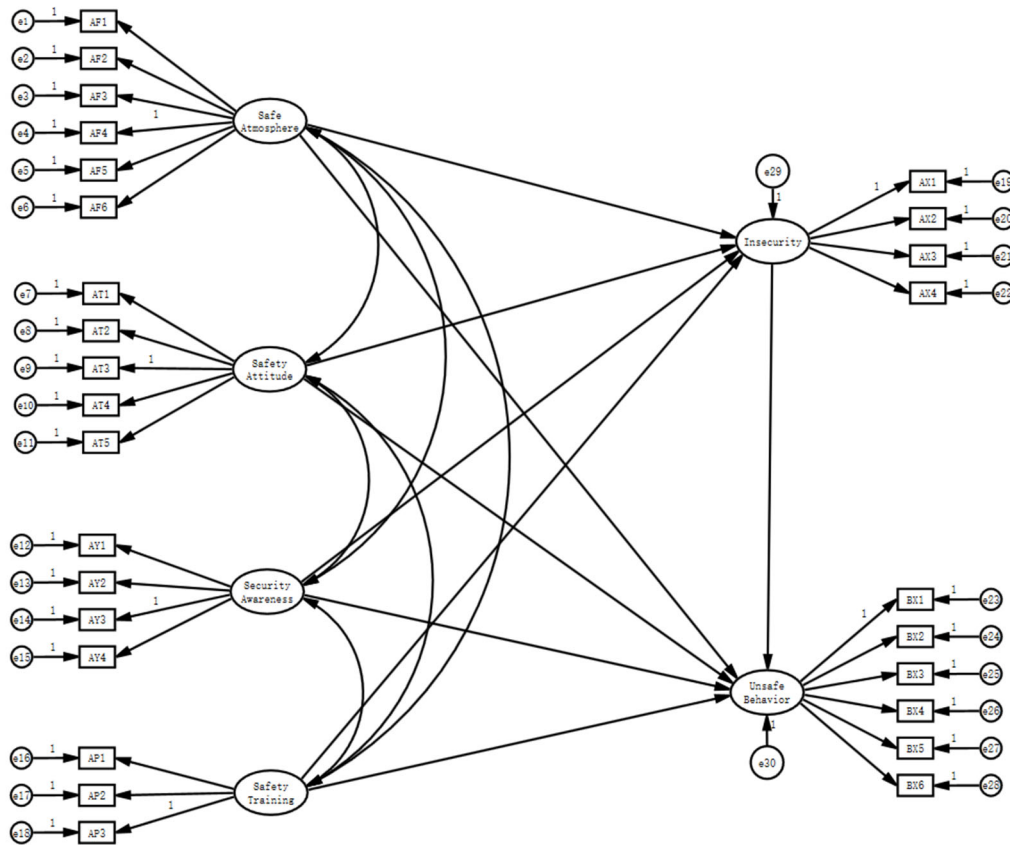


Figure 1. Structural equation model of the influence of safety culture level on unsafe behavior

3.6. Results analysis

Safety attitude to the influence of unsafe psychology, the influence of safety consciousness is not significant, assuming H 6 and H 7, through the analysis, improve the safety awareness and safety attitude, easy to make coal mine workers have reverse psychology, and promote the production of unsafe psychology, so safety consciousness and safety attitude and unsafe psychology. Safety atmosphere, safety attitude, safety awareness and safety training have a direct

impact on the unsafe behavior of coal mine workers, while the safety atmosphere and safety training also indirectly affect the unsafe behavior of coal miners through the unsafe psychology. The influence of each variable on unsafe behavior is safety attitude (0), safety atmosphere (0), safety training (0) and safety awareness (0); the path coefficient of unsafe psychology on unsafe behavior is 0..82.67.67.54.79

4. Unsafe Behavior Intervention Countermeasures

(1) Create a good working atmosphere

Coal mine management staff is the guide of the enterprise, the influence of the miners, management should increase the emphasis on safety, to participate in the safety work, make employees feel the attention of management to the safety, change staff safety consciousness, create a safe working atmosphere, reduce the occurrence of coal miners unsafe behavior.

(2) Strengthen safety training and assessment

Safety training has important influence on the improvement of safety awareness of coal mine workers, through the establishment of long-term training mechanism, the theory teaching, field field, network training, apply the powerful theoretical knowledge to the scene, instill safety behavior, improve the safety consciousness of coal miners, make coal workers in subjectively strengthen safety attitude, to avoid unnecessary unsafe behavior.

(3) Reduce the work pressure of workers

Coal mining enterprises should formulate and perfect a reasonable working system, clarify the work objectives and workload of workers, give appropriate rewards to workers, improve the work enthusiasm of miners, reduce the work pressure of workers, so as to reduce the occurrence of unsafe behaviors.

(4) Strengthen the investment of safety facilities

The underground working environment of the coal mine is bad, so the coal mine enterprises should constantly take scientific means to improve the working environment, and strive to reduce all kinds of adverse safety factors caused by the bad safety facilities, so as to create a good and safe working environment for the coal mine work.

(5) Enhance the awareness of safety responsibility of coal mine workers

Coal mining enterprises must strengthen the guidance of coal mine workers, often organize workers to watch the typical coal mine accident safety analysis, illegal personnel in safety education activities, prompting workers to fully realize the seriousness of the consequences, the coal miners from the psychological understanding to the dangers of unsafe behavior, improve their own safety responsibility consciousness.

5. Conclusion

This paper, first through literature analysis and sorting, find out the four factors of safety culture level, unsafe psychology as the mediation, using the structure equation model to test

the influence of the unsafe behavior research, and put forward the corresponding intervention countermeasures, so as to reduce the unsafe behavior of coal mine workers, has a positive influence on coal mine safety accident prevention.

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