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Research Article

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Mine safety production risk early warning and evaluation

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ABSTRACT

In this paper, complexity theory is regarded as guiding ideology, meta-synthesis method from qualitative to quantitative is regarded as supervising method, and it integrates many theories and methods, such as, complex science theory, risk early warning theory, data mining technology, combined with the empirical analysis, the knowledge of risk early warning in coal mine safety production was studied.

Keywords: Mine Safety, Early Warning, Evaluation

INTRODUCTION

The industry of coal mine is a high risk industry in China, the frequent occurrenceof coal mine accidents caused a great loss to the country and people, which seriouslyaffect the construction of harmonious society, it also had a bad influence in internationalcommunity. In the management of coal mine safety production, changing the passiveand the empirical mode of safety management to the proactive and the comprehensiverisk early-warning model is the key to solve the frequent occurrence of coal mineaccidents effectively in China. Meta-synthesis method from qualitative to quantitative isregarded as risk early warning guidance in mine safety production, on the basis ofcollecting comprehensive risk information, judge risk state of system in advance bywarning knowledge rules and warning models, then achieve the goal of alarm in time about current unacceptable risks and real-time warning about future risks. Preventionand control measures can be taken in advance based on the results of early warning, sothe coal mine accidents can be eliminated, reduced and controlled. Implementing riskearly-warning in mine safety production has great significance in implementing thepolicy of the safety production, which is Safety First, Prevention Primary,Comprehensive Treatment, it also has great significance in improving the currentserious situation of safe production in coal mine.

Theoretical analysis and research hypothesis

Elements of competency are those who work with work or performance directly related to the knowledge, ability, character, function or motivation, knowledge, skills, ability, motivation, ideas, values and interests of the integrated [2]. Learned from the ergonomics theory, the human error factors include physiological, psychological content, professional skills. Physiological function including basic conditions, physical strength, endurance and energy; psychological content include the individual character, individual psychological tendency, to external stress, focus and concentration level; professional skills including professional knowledge, professional technology and working attitude. According to the human engineering theory and points out that the personnel physiological factors are fundamental to ensuring staff efficient, accurate operation. Height, audio-visual, arms, body weight, strength, heart and lung function is the basic condition to complete the assignment operator. The employee's physical strength, energy and stamina is to ensure the continued safe, efficient operations staff security [3]. Safety psychology theory suggests that individual characteristics, staff attitude, stress psychological tendency and psychological acceptance of work will affect the staff work process reliability and safety performance directly. Employee distraction, awareness level and willpower is low is the main reason leading to reduced reliability of operation. Staff at the competent state

must be aware, consciously govern their actions, and can focus on work process, to ensure that the process is accurate and has good safety performance. According to the competence theories, the staff only has the knowledge and skills associated with high performance, and high work desire and sense of responsibility, can reduce human error and achieve higher safety performance in the operating process. Reliability in operation process includes information awareness, the recognition process of judgment, reliability in operation process. Coal mining enterprises to measure operational safety performance indicators include human error rate, violation rate and accident rate. The reliability of operation process is to ensure safe operation of the foundation and precondition of [4]. Only in the process of operation and high degree of reliability, human error rate can be reduced, the staff unconscious violation and accident will be reduced. Therefore, this paper to detect, use the following constants such as H1: physiological factors have a significant positive effect on employee job process reliability; H2: physiological factors have a significant positive effect on employee safety performance; H3: psychological factors have a significant positive effect on employee job process reliability; H4: psychological factors have a significant positive effect on employee safety performance. H5: professional skills factors have a significant positive effect on employee job process reliability; H6: professional skills factors have a significant positive effect on employee safety performance; H7: staff work process reliability has significant positive effect on employee safety performance.

Security for investigation of influencing factors

This survey is mainly on the investigation of coal mine operators the last shift state of physiological function, psychological function, professional skills, process reliability and the safety performance. The questionnaire is quoted by Li Kete's six point scale. In the state of physiological function, investigation, design the corresponding problem from four aspects of basic conditions, physical strength, stamina, energy; in the psychological status investigation, from the personal character, temperament, personal psychological tendency, attention, volition and consciousness level six aspects corresponding problems in design; professional skill state survey, design the corresponding problem from three aspects: professional knowledge, technology and work attitude; investigation of process reliability, from the information process of perception, recognition process and operation procedure three aspects corresponding problems in the design of safety performance; the survey, from the human error rate, error the event rate, violation incidence corresponding problem design.

To ensure that the questionnaire has good reliability and validity, the application of DelphyFa for advice on the questionnaire, and reach a consensus of opinion, that the design of the survey items are scientific and reasonable. Then the questionnaire to 30 students Pingmei shares first-line team leader training, on-site interview questionnaire and language expression is accurate and easy to understand, and according to the interview and revise the content of the feedback.

Questionnaire

In this paper, the survey in coal enterprise operators as the research object, through the questionnaire survey method to obtain reliable data, the actual analysis of the hypothetical situation, investigating a shift operator about state of physiological function, psychological function, professional skills, work reliability and safety performance. Questionnaires in the mine operator l well class will, the survey provided 400 questionnaires, recycling 385 copies, of which 356 valid questionnaires, the questionnaire has 85.3% efficiency, achieve the survey requirements.

Research methods

The coal mine safety for operator competent state factors using structural equation model (SEM) method is verified. The use of SPSS17.0 analysis of validity and reliability of the questionnaire.Using AMOS17.0 software for structural equation model test of goodness of fit and analysis of [5] on the path.

Tab.1 the questionnaire Crobach 's coefficient

Factor	Crobach's Value	Item number	Scale Crobach 's value
Physiological function	0.745	4	0.902
Psychological function	0.856	6	
Professional skills	0.913	3	
Process reliability	0.897	3	
Safety performance	0.916	3	

Reliability and validity analysis

In this paper, using the SPSS software tools and the use of Crobach's coefficient method to detect the [6] questionnaire. And the level of reliability validity is a questionnaire based good, influence on subsequent data analysis results, the reliability coefficient alpha values of the best >0.80 subscales, and best >0.70. In the scale, if the internal consistency coefficient below 0.50, the total scale, reliability coefficient below 0.70, have to modify the scale and change the items. Table 1 lists the design of each subscale of the Crobach's coefficients, the values are

greater than 0.7, the questionnaire reliability requirements.

The application of SPSS software to get the KMO test value, and the questionnaire validity analysis of method of test for Bartley sphere. According to Kaiser KMO>0.9, said very suitable; 0.8 < KMO < 0.9 for more than 0.7; in May, 0.6 when the effect is poor, if KMO<0.5 is not used for factor analysis. After data analysis that the value of KMO 0.835, greater than the critical value of 0.7, significant probability and factor values is 0, less than 0.001, thus, the questionnaire data obtained with factor analysis.

Path analysis

Through the model of structural equation analysis, summary the path coefficients between factor loadings, the latent variable and table 2.

Tab.2 the factor loading and path coefficient

Route	Standard estimates	Test valuet	Route	Standard estimates	Test value t
ξ1→η1	0.758	3.65	ξ2→x7	0.568	7.244
ξ2→η1	0.539	4.045	ξ2→x8	0.595	7.579
ξ3→η1	0.786	12.99	ξ2→x9	0.673	8.575
ξ1→η2	0.139	1.102	ξ2→x10	0.679	8.652
ξ2→η2	0.102	1.277	ξ3→x11	0.85	8.105
ξ3→η2	0.832	12.004	ξ3→x12	0.875	8.159
η1→η2	0.857	6.426	ξ3→x13	0.583[b]	5.252
ξ1→x1	0.662	7.914	η1→y1	0.586[b]	
ξ1→x2	0.703[b]	8.21	η1→y2	0.726	7.176
ξ1→x3	0.835	9.305	η1→y3	0.678	6.883
ξ1→x4	0.529	6.426	η2→y4	0.773[b]	
ξ2→x5	0.692	7.914	η2→y5	0.811	9.723
ξ2→x6	0.728[b]		η2→y6	0.630	7.847

Note: the factor loading with superscript "B" index in non standard case is fixed at 1, without calculating the T values

We can see from table 2, the vast majority of test value t is greater than the 1.96 fitting requirements, load factor of 2 and ξ 1, latent variable ξ 2, 1 and ξ 3, ETA ETA were greater than 0.5, visible observation variables can explain the latent variables and the corresponding.

hypothesis testing

In this paper is about the analysis and testing of the 5% significant level, and the results aresummarized in table 3. Among them, assuming H2 and H4 did not pass the significance test, hypothesis cannot be established. H1, H3, H5, H6 and H7 pass the test of significance, hypothesis.

Tab.3 hypothesis testing

Hypothesis	The path coefficient	Test value t	Result
H1：Physiological factors have a significant positive effect on employee job process reliability	0.758	3.65	**found**
H2：Physiological factors have a significant positive effect on employee safety performance	0.139	1.102	false
H3：Psychological factors have a significant positive effect on employee job process reliability	0.539	4.045	**found**
H4：Psychological factors have a significant positive effect on employee safety performance	0.102	1.277	false
H5：Professional skill factors have a significant positive effect on employee job process reliability	0.786	12.99	**found**
H6：Professional skill factors have a significant positive effect on employee safety performance	0.832	12.04	**found**
H7：Staff work process reliability has significant positive effect on employee safety performance	0.857	6.426	**found**

From the angle of theory analysis and common sense of life, the operator physiological and psychological factors have significant positive effect on employee work safety performance, but the empirical study shows that the mine operator physiological factors and psychological factors have a positive effect on employee safety performance, but the effect is not significant. The empirical analysis come to an conclusion that function of physiology factors and psychological factors have a significant positive effect on the performance of staff work process reliability, staff work process reliability has significant positive effect on employee safety performance, which can deduce the operator physiological factors and psychological factors have positive effect on employee safety performance through the mediating variable process reliability. Based on the above empirical analysis, this article believes that

coal mine safety for operator competence status refers to the operation of work process with high reliability and good safety performance, with the individual state of physiological function, psychological function and professional skills, is a kind of dynamic state that moment.

Countermeasures

(1) The establishment of coal mine operators matching mechanism of psychological factors

Coal mining enterprises in the process of hiring employees or arrange task, not only to pay attention to professional skills, deal with the employee's personal character, temperament and personality (interest, values, etc.) to make scientific evaluation and post matching degree, and according to the evaluation results of staff posts and make reasonable adjustments. By matching mechanism can effectively improve the matching degree of employee personality psychology and post mine operators to establish psychological factors, effectively improve the working interest, so that the right people in the right positions, improve process reliability.

(2) The establishment of psychological function operator mine evaluation mechanism

In the changeable and complicated social environment, each worker is in a different environment, experiencing a variety of shocks, when workers face an important choice or family crisis, the balance of heart will be broken, when the psychological burden and overloading, operator a sense of inner balance is not timely reconstruction, will cause the workers distracted, stress disorder, weak willpower, arousal level drop and a series of consequences, psychological state of unhealthy can no longer competent job requirements. Therefore, through the establishment of evaluation mechanism of mental function operator mine effective psychological function no longer competent state selected staff work requirements, and psychological intervention in its, make its attention, awareness for the arousal level, will force capable of operating requirements.

(3) Improve the mine operator skill factors evaluation mechanism

Professional skill factors of coal mine operators are the basis for the correct and safe operation of the staff. In the coal mine operators pre-evaluation system, need the professional function factors, selected to meet the requirements of the staff, for the incompetent employees, need to further strengthen the education and training of professional skills, only to meet job requirements, and then arrange the work.

CONCLUSION

Professional skills and operation reliability of coal mine operators have a significant positive effect on employee safety performance, physiological factors, psychological function factors through operation reliability has a positive impact on the safety of the staff performance. The risk early warning model based on set-pair analysis theory was studied.Point to the uncertain feature of risk, analyzed the description of risk state byconnection degree based on the description of macro and micro evolution, and analyzedthe uncertain interval of connection degree by catastrophe model; proposed thirdwarning degree for dominant risk and fifth warning degree for recessive risk base onset-pair analysis model, then verified by examples.

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