International Journal of Security and Its Applications
Vol.9, No.8 (2015), pp.375-384
http://dx.doi.org/10.14257/ijsia.2015.9.8.33

Research on Factors Affecting Employees' Security Behavior Based on Structural Equation Model

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Abstract

Investigation and literature research show that human error is one of the main reasons in coal security accident. Therefore, not only the study of employee's behavior and the coal accident are the premise to prevent coal mine security accidents, but also the foundation of effective management on employee security behavior. In view of the complexity of mine security, establishing a structural equation model of mine security to make empirical research. By using SIMPLIS and SPSS software to estimate model's parameter and best-fit, identifying causal correlation and path between employee security and mine accidents. As a result, provide a theoretical foundation for the research of security management. At the same time, offering new thoughts for related research.

Keywords: *Coal mine accident, behavior, employee security, structural equation model, path coefficient, causal correlation*

1. Introduction

According to China Economic Net statistics, in 2015 China's coal industry is still grim. Coal economic operation situation report shows that the first 11 months of 2014, coal enterprise profit fell by 44.4% year on year, the loss of the company's losses grew by 61.6%, and the loss area of the enterprise reached more than 70% [1]. There are a number of studies have shown that more than 80% of China's coal mine accidents are caused by human factors. In 2014, national various types of production safety accidents and deaths fell by 2.6% and 8.8%, respectively, the number of serious accidents and deaths fell by 25.6% and 16.9% [2]. On May 8th 2014, China News Network reported that in 2013 the number of coal mine accident death toll was 1067 people, and Coal million tons mortality rate was 0.288 [3]. In order to effectively control the occurrence of coal mine accidents, what's more, reduce casualties and property losses, understanding coal production technology level, in-depth study employees' unsafe behavior and mechanism, improve coal mine employees' safe awareness, and effectively reduce the incidence of coal mine accidents.

2. Literature Review and Comment

Employees' unsafe behavior research originated in the 1990s, it mainly focus on unsafe behavior and its influencing factors. A. Neal, MA. Grimn [4] think of that employees' security participation behavior helps enhance security environment, improve employees' security awareness. Therefore, it is important and essential to

ISSN: 1738-9976 IJSIA

strengthen employees' security behavior. Tie-zhong Liu, Zi-wei Wang, Wei Li, Zhi-xiang Li [5] describe optimization strategy of SMCCM from perspective of utility of coal miner with the method of empirical research. Their conclusions are that: first, "rule safety knowledge" should be strengthened above all; second, "job satisfaction" should be paid more attention to; third, coal miner's benefit should be concerned specially. Hong Chen, Hui Qi, Ru-yin Long [6] suggest establishment of active psychological contract to enhance the coal mine safety management level. Baker A, Heiler K, Ferguson S A [7-8] think that the combination of excessive work hours and lack of consultation with employees regarding the second change may have contributed to the overall negative effects. Chun-jing Gao, ping-qing Liu [9] describe that market price of product, rate of worker' wage and government regulation are highly imperfect alternatives concerning the reduction of disasters in coal and mine enterprises. In turn, continued reliance on all three approaches, a rational mechanism among government, employee and employer should be established.

Gang HE, Guo-tong Qiao, Hua-liang Cao, Xia Yang [10] by analyzing SD simulation of enterprise human capital investment costs and income levels to improve coal mine security management and employee security level behavior. Kai Guo [11] aim at enterprise security management, study proposed mine security factors, but it ignores the influence of human factors, the study is not very comprehensive. From the driver's and security managers' perspective, Fang-yuan Li [12] by the way of using SPSS and AMOS software to determine the impact of the path and the influence of major accidents on the transport enterprises human performance and unsafe behavior. Xiang-sheng Tian, Yun-cai Ning, Chong-shan Ren [13] apply literature research method, comparative research method and applicant research method to analyze the reason for current status of low staff quality in coal mine of china, and approaches to build high-quality coal mine staff team were proposed. Xue-cai Xie, Zhen-hong Yang, Gui-ge XU [14] take a mine in Shanxi as an example, they have adopted the HFACS model they have prepared along with the expert scoring and analytic hierarchy process (AHP), and as a result, we have made account of the joint degree expression of the system. Analyzing the expression of the set pair potential of the mine, the connection degree, uncertainty and negative potential, we have made a conclusion that this mine is in a proper safety condition though some human factors are to be brought about to the position, such as the mining safety culture, the psyche state of the workmen, as well as such factors as the emergency response capabilities. Hong-xia Li, Jian-wen Xue, Heng Zhang, Shui-cheng Tian, Meng Jin [15] introduce that the likely-to–be-wrong management can be expected to be a very significant original causes that may account for such coal mine accidents. At last, the study results show that the coal mining safety environment tends to affect the safety performance of the coal miners and their safety behaviors.

Nowadays, the study on the Chinese coal mining enterprises for employees' security behavior is not perfect, most of which focus on qualitative analysis and static research. Moreover, quantitative research and considerations lack of standards. Employees' unsafe behavior control and management lack of theoretical basis. At the same time, it also lack of research on the basis of reliability and validity.

3. The Factors That Affect Employees' Security Behavior Based on Structural Equation Model

Structural equation model is a statistical method provided by Kar.G.Jorskog and his collaborators. It can help people to improve the ability of handling data and then use a series of data to evaluate this model. By using structural equation model to analysis coal mine accidents and employees' unsafe behaviors, it is also an attempt to secure management.

As for employees' security behavior, the analysis of coal mine security is a complex process. According to the research and analysis, this paper selected four major factors, which associated with coal mine security. It includes employees' safe behavior, security management, environment security and organizational politics. Employees' safe behavior as the main factor in the study of coal mine accidents occurred; the other three factors are looked as if the secondary study. On the basis of above research, we use SIMPLIS and SPSS carry out empirical analysis in the model, trying to find a causal relationship between employees' security behavior and security management, environment security, organizational politics.

3.1 Extract Key Indicators

Considering the complexity of coal mine security, our teammates repeatedly get into Anhui coal mine to do research. At first, we choose factors that affect miners' security to design questionnaire. Furthermore, we apply Likerts' 5-point scale to assess amount. "1" stands for strongly disagrees; "2" describes disagree; "3" shows neither agree nor disagree; "4" denotes agree; "5" represents strongly agree, the level of reception from "1" to "5" is becoming higher and higher. The content of the questionnaire described as follows:

(1) Employees' security behavior (ξ). It dedicates the identification of the miners' security awareness and reaction to risk behavior. John Friedl use the concept of explanatory model , popular and professional health cultures are analyzed, focusing on course of disease, sick role, appropriate treatment, and expected outcome [16]. Differences in explanatory models are discussed with regard to implications for the organization and delivery of care to retired coal miners with black lung. Brian L. Quick appeals to normative influences may be the most effective antecedent to employ when persuading coal miners to wear hearing protection [17]. Kunar Bijay Mihir use the conditional logistic model to assess the relationships of job hazards, individual characteristics, and risk taking behavior to occupational injuries of coal miners [18]. We designed four questions. ξ_1 : Describes what our working environment is very dangerous. ξ_2 : Shows that employee and employer pay attention to the security rules. ξ_3 : Represents that employee won't operate illegally. ξ_4 : This usually stands for employee do regular training activities about security when work.

(2) Security management (η). This refers to the coal mine management. Highlights • Error management climate predicted supervisor and co-worker safety support, within-team safety communication, and safety behavior [19].Within-team safety communication predicted workers' safety behaviors. Some authors study coal safety management based on risk pre-control [20, 21, 22, 23]. They list three steps. First, the hazard sources are identified before coal mine accidents occur, and then the pre-control measure and information monitoring method based on classifying the hidden hazard sources are given. Lastly, the risk pre-alarm and risk control method are confirmed. Guo-yu Liu, Chuan-long Luo focused on the exploration about some psychological factors in the coal mine accidents, and then gave the methods to evaluate the safety psychological factors in the safety production. The facts proved us that it had caution effect to the coal mine accident, and at the same time the coal mine principal should attach importance to miners' psychological education [24]. With regards to the topic, our teammate as well as design four topics. namely η_1: Miners' working pressure; η_2 : Manager attaches great importance to coal mine security; η_3 : Coal mine accident rate is very low; η_4 : Working long hours in the mine.

(3) Environment security (λ). It refers to environment security in coal mine. Ryan Johnson, R.M. Bustin described coal environment in 2006 [25]. Since 1977 the main

deposition of coal has occurred in the vicinity of the coal-loading terminals, where concentrations of 10.5% and 11.9% NHS (non-hydrolysable solids = coal) occur. The settling properties of fresh and oxidized coal particles (<53 μm up to >2.36 mm) were examined in order to better understand the dispersal of coal in marine waters. Nyakundi M. Michieka thinks that China possesses the second largest coal reserves globally and is the largest producer of coal in the world. Approximately 95% of the coal produced in China is from underground mining, which causes serious environmental and water quality problems [26]. As references, we design three topics on it. λ_1: Our environment is very clean. λ_2: Whenever and wherever you are a skilled operator. λ_3: Regular inspect underground environment and maintenance of equipment in place.

(4) Organizational politics (θ). It represents coal mine's management structure and the fairness of management. Karmis, Michael first call for proposals, released on Jan. 18, 2013, announced a request for concept papers addressing one of the four priority target areas: safety, health, safety and health management, training [27]. H. Tezcan Uysal, Emel Kesim aim to determine the organizational burnout, organizational commitment and job performance levels of the employees that work in coal mining and finding out the influences of these levels upon each other. In the result of the analyses carried out, while it was determined that 1 unit of increase in organizational burnout level caused 0.460 unit of decrease in job performance [28]. Moreover, Human factors have an important impact on a successful evacuation. To address the above problems, in this paper, we established a framework for human error risk analysis of coal mine emergency evacuation, consisting of scenario and task analysis, risk assessment and risk reduction [29]. On the basis of above discussed, we design four topics. namely θ_1: whether the management structure is very reasonable or not, θ_2: if managers can equally exchange with miners, θ_3: management is very fair-minded, θ_4: miners' task allocation is fair.

3.2 Data Collection and Collation

In order to ensure the timeliness and validity of the data, our teammates do research in Anhui major coal. As the research object, this paper selects four large coal mines in Anhui Province. Take questionnaire survey method as a major research tool. Moreover, we use a random sampling method to extract testers. All in all, 400 questionnaires are distributed; 357 questionnaires are cumulative recovered, and 318 are valid questionnaires. In the end, the effective rate of the questionnaires is 79.5%.

It is true, broad and representative for collected data. We use SPSS to analysis data, and with the help of SIMPLIS to conduct model. Furthermore, we use Likert scale method and principal component analysis, in-depth analysis the impact factors of the role of coal mine employees' security behavior.

4. Select a Case to Start Empirical Analyses

4.1 Testing Reliability and validity

In this paper, data analysis is performed using SPSS, then, the raw data is imported. As a result, we get the mean, standard deviation and Alpha values of each component. Among them, employees' security factors whose Cronbach's Alpha value is equal to 0.737, to which Alpha value equals 0.750 after standardization. As shown in Table 1.

Table 1. The Validity and Reliability of Employees' Security Factors

	Variable	mean	Standard deviation	Cronbach's Alpha	Standardized Cronbach's Alpha
Employees' security behavior	ξ_1	4.8409	0.63862	0.737	0.750
	ξ_2	4.4675	1.08989		
	ξ_3	4.4214	0.67331		
	ξ_4	4.5692	0.91596		

Similarly, we can get another three variables' Alpha. Take the security management for example, of which Cronbach's Alpha value is equal to 0.789; the normalized Cronbach's Alpha value is equal to 0.799. As described in Table 2 below.

Table 2. The Validity and Reliability of Security Management Factors

	Variable	mean	Standard deviation	Cronbach's Alpha	Standardized Cronbach's Alpha
Employee's security behavior	η_1	4.0779	1.18916	0.799	0.799
	η_2	3.8961	1.19809		
	η_3	3.6753	1.44332		
	η_4	4.1136	1.22810		

Thirdly, whether coal miners' working environment is safe, clean or not; whether there is sufficient oxygen; and gas concentration is below the standard value; if ventilation is good, and so on, what described above have an largely impact on miners' safety behaviors. So to keep the environment security is essential. After careful, comprehensive and detailed calculations, we get the Cronbach's Alpha value of environment security, which equals to 0.785; after standardized, its Cronbach's Alpha value equals to 0.824. As shown in Table 3.

Table 3. The Validity and Reliability of Environment Security

	Variable	mean	Standard deviation	Cronbach's Alpha	Standardized Cronbach's Alpha
Employees' security behavior	λ_1	4.5357	1.18981	0.785	0.824
	λ_1	4.7045	0.79925		
	λ_1	4.8117	0.68268		

Table 4. The Validity and Reliability of Organizational Politics

	Variable	mean	Standard deviation	Cronbach's Alpha	Standardized Cronbach's Alpha
Employees' security behavior	θ_1	3.4935	1.57442	0.843	0.845
	θ_2	2.6266	1.64630		
	θ_3	3.3117	1.51655		
	θ_4	3.6169	1.49133		

Last but not least, reasonable organizational policies that ensures safe production in coal mines. National Development and Reform Commission of China held a special

meeting in 2015, which proposed the "four strict". It includes: strictly control the production of illegal construction; strictly control over the ability to produce; strictly control unsafe production; strictly control the production and use of low quality coal. In May, National Energy Board of China promulgated two documents, which included “the notice about strictly control the capable of over-producing in mine” and “the notice of eliminate backward production capacity on the coal industry in 2015 should be completed” [30]. Therefore, we calculate the Cronbach's Alpha value of organizational politics is equal to 0.843; Cronbach's Alpha value is equal to 0.845 after standardization. As described in table 4 above.

The Cranach's Alpha coefficient mean of questionnaire is 0.7885; the normalized Cranach's Alpha value is 0.8045. According to study on the internal consistency of Cronbach α coefficient, α coefficient greater than 0.7 indicate more credible investigative; α coefficient greater than 0.8 indicate very credible investigative; α coefficient greater than 0.9 indicate extremely credible investigative. In this questionnaire of the paper, Cranach's Alpha coefficient greater than 0.8 after standardized, which indicates that the survey instrument is very credible, so the questionnaire has good internal consistency. The internal consistency checks describe from table 1 to Table 4.

4.2 Analysis of Survey Results

After all preparations are completed, entering the original data in SPSS. What’s more, by using principal component analysis, the SPSS software displays iterative convergence after rotating nine times, which extracts four factors among them. Its characteristic value is greater than 1; the cumulative value of variance is 82.901%, which is apparently meeting the requirements. Then, with the data entered in SPSS software, we run SIMPLIS. At last, analysis the running results, we draw the path coefficients. As shown in Figure 1 and Table 5.

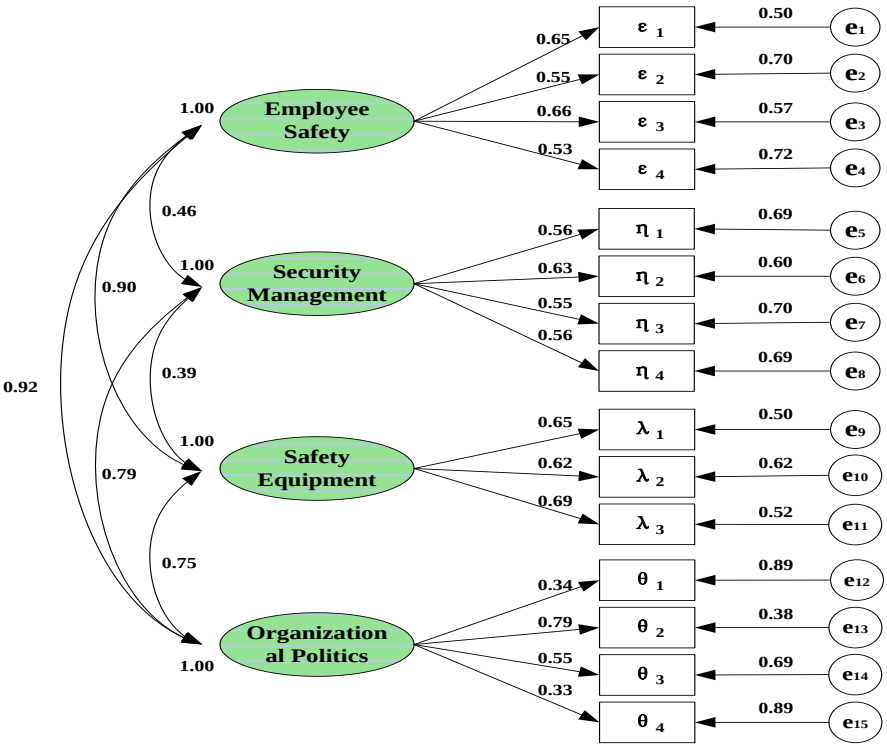

Figure 1. The Path Coefficient of Employees’ Security Behavior Influencing Factors

Table 5. KMO and Bartlett's Test

Sampling sufficient degree of Kaiser-Meyer-Olkin measure		.804
Bartlett's test of sphericity	The chi-square approximation	285.30
	df	87
	Sig.	.000

By observing the operating results, the data shows it converge 18 iterations, the Bartlett's test chi-square is 285.30; and the degree of freedom is 87, both of which have reached a significant level. So it is suitable for factor analysis.

As is apparent in Table 6, GFI (Goodness of Fit Index) is equal to 0.92 more than 0.900, AGFI (Adjusted Goodness of Fit Index) is equal to 0.88 more than 0.800, RMSEA stands for Root Mean Square Error of Approximation, The smaller its value is, the better it indicates the appropriate model. The chi-square value (CMIN column) is 2.8964, which is not significant, accepting the null hypothesis. It shows that the hypothesized model and sample data can be adapted. Root Mean Square Error of Approximation (RMSEA) is equal to 0.001, which is less than 0.080. So there is no doubt that the model can be adapted to meet the standards.

Table 6. The Evaluation Value of Model Fitting

Index	χ^2	GFI	AGFI	NFI	RFI	RMSEA
Reasonable value	<3	>0.9	>0.8	>0.9	>0.9	<0.08
Evaluation value	2.8964	0.92	0.88	0.92	0.97	0.068
Benchmark Results	Qualified	Qualified	Qualified	Qualified	Qualified	Qualified

To sum up, the model contains fifteen indicator variables and four facets of the factors. According to the above discussed, establishing fifteen regression equations, just as the following equations.

$$\varepsilon_1 = 0.65\varepsilon + 0.50 \quad \eta_1 = 0.56\eta + 0.69 \quad \theta_1 = 0.34\theta + 0.89$$
$$\varepsilon_2 = 0.55\varepsilon + 0.70 \quad \eta_2 = 0.63\eta + 0.60 \quad \theta_2 = 0.79\theta + 0.38$$
$$\varepsilon_3 = 0.66\varepsilon + 0.57 \quad \eta_3 = 0.55\eta + 0.70 \quad \theta_3 = 0.55\theta + 0.69$$
$$\varepsilon_4 = 0.53\varepsilon + 0.72 \quad \eta_4 = 0.56\eta + 0.69 \quad \theta_4 = 0.33\theta + 0.89$$

$$\lambda_1 = 0.65\lambda + 0.50$$
$$\lambda_2 = 0.62\lambda + 0.62$$
$$\lambda_3 = 0.69\lambda + 0.52$$

5. Conclusions and Prospects

The research of coal miners' security conduct can help coal mine enterprises to improve their internal security, and reduce the incidence of coal mine accidents. Moreover, it helps to improve management quality and reduce accidents on unnecessary human factors. Through the use of structural equation model, we can find approaches to employees' security behavior and the main factors about coal production were studied, the following is main conclusions and the follow-up research proposals:

(1) Coal miners' security behavior with security environment and the organizational politics have significant relevancies. In figure 1, it shows the absolute path value, among this, correlation coefficients between coal miners' security behavior and security environment is 0.98; the correlation coefficients of coal miners' security behavior and organizational politics is 0.92. It is obvious that security environment has the biggest impact on the behavior of the miners. So keep working environment clean and tidy for coal mine security is essential, especially for mines' security

operation. To various coal companies and individual miners concerned, the role should be carefully got attention.

(2) Between security management and organizational politics has a direct influence to each other. The correlation coefficient between security management and organizational politics is 0.79; it indicates that a reasonable management structure has a positive effect on miners' security behavior. This is the reason why the management structure and management methods will be able to explain the security of coal mine enterprises. Moreover, in order to implement the new law about coal mine. "Safety Production Law", "the Chinese State Council on strengthening the safety production supervision and law enforcement" and other related documents have been implemented. To further regulate coal mine enterprises' safety training so as to improve the quality of employees in security. Effectively prevent and resolutely curb the occurrence of accidents, and finally security management and organizational politics make better together, complement each other.

(3) Lei Xing, director of the Central University of Finance and Economics [31]. He said that "Coal companies must get rid of the past that the idea of over-reliance on policy supports and ideas, they are supposed to learn to swim in a market economy. At the same time, they must be concerted rather than do fratricide and vicious competition. Nowadays, the most need to do for coal mine enterprises is to work together to achieve the healthy and stable development of coal economy". A large part of the security environment depends on the political influence of the organization. The more reasonable the management structure, the higher efficiency of the management. Only keep better security environment for coal mining enterprises, can organizational politics improve greater. Therefore, to enhance the security of coal miners' behavior has a vital role in the political aspects of the organization. Therefore, security environment and organization policy of coal enterprises should be adjusted accordingly.

Finally, we talk about prospects of the article. Figure 1 can not give the dynamic association of miners' safe behavior with security management and security environment even organization policy. This data of research based on large state-owned coal mines, whether applied to the Chinese local coal mine and coal mines in other countries, it is still unknown, we expect to confirm the follow-up study.

Acknowledgements

This work is supported by the following programs: the Chinese Students' Innovation and Entrepreneurship Training Program (NO. 201310361104) ; the National Natural Science Foundation of China with the title "Evaluation of Coal Miners' Safety Behavioral Ability and Its Dynamic Pre-warning under the Interaction between Individuals and Environment" (NO.51574010); Research Project of the key base of Humanities and Social Sciences in Anhui Province (NO. SK2014A041)

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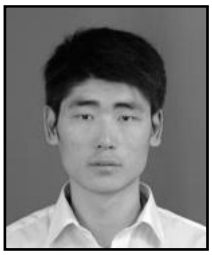

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