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Influence Factor Analysis of Coal Mine "Three Violations"

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Abstract. "Three violations" was one of important reason of causing coal mine accident which was identified in three grade factors according to a Shanxi mine: 3 factors in primary grade, 6 second grade factors, 25 three grade factors, reasonable questionnaire was formulated while acquired first-hand data through researching on 300 workers and management personnel. Constructed judgment matrix to calculate the weight value of factors relying on yaahp software, the weight average value of each influence factor was obtained by combing with average date of the questionnaire , two important factors of impacting the mine safety was founded, it could provide scientific and reasonable guidance for safety production.

1. Introduction

Safety production is an important consider issue for coal mine enterprise and has received great attention, most accident is caused by "three violations" behavior which violation of operation rules, violation of operation procedures, violation of labor discipline, it Includes nonstandard operation behavior, incomprehension operation rules, working with an unsafe psychology, an illegal command and violating labor discipline and so on, so finding the reason of "three violations" to solve coal mine safety problem is very important. Hofmann and Stezer think overload task lead work stress which affects safety behavior, time, lack of training and resource could affect job performance; Cao Qing-ren finds that management behavior has a significant effect for safety knowledge and motivation of mines, design behavior affects safety knowledge and motivation of mines through management behavior; Zhang Mei, Li Lin in the paper draws the conclusion: through analysis of physiological, psychological before coal mine accident occurred find psychological factor of miners related to coal mine accidents, which are: paralysis, labor force, weary and lucky psychology and so on [1,2,3].

Research on coal mine safety problem is to find out why "three violations" occurred from management through theoretical analysis in recent years, it has often only one aspect, the correlation between various factors and influence also does not take into account, and using the method of qualitative analysis is more, so in the process of application to the actual enterprise guidance is not specific and reliable. This paper improves the previous defects and selects a special mine as research object.

2. Define Influence Factor of "Three Violations"

2.1 Define Influence Factor and Site Investigation. In analysis of mine safety factor, using 300:29:1 rule of Heinrich who American famous safety engineer, it is purposed in the rule that there are 29 minor in the back of a major accident, as well as 300 potential pitfalls. Occur a major coal mine accident is this a large number of potential hidden danger [4]. A lot of field research and discussion with management staff and workers is operated according to actual circumstance of coal mine, find that "three violations" is an important reason for accident combined with facilities, personnel and enterprise management status. The reason includes three aspects which primary level factors: individual factor, environment factor and management factor, next define the second level factors.

A) Individual factor. Individual factor is direct reason that causing "three violations" which can be divided into 3 second grade factors such as individual accomplishment, physiological factors and psychological factors. Individual accomplishment include responsibility, attitude, education, length of service; physiological factor contain fatigue, work intensity, rest rule; psychological factor involve lucky, paralysis, foolhardy, habit and against, 12 third grade factors in individual factor.

B) Environmental factor. To analyze from the angle of environment impact on the people, unsafe behavior of people in addition to from the human self, and inseparable from outside environment at the same time, environmental factor also can be divided into three second grade factors, including working environment, family environment, social environment.

Working environment include monitoring and protection facilities, work equipment, natural environment; family environment consist of household income, relationship between family members; social environment involve workers relationship、relationship between cadres and workers, there are 7 third level factors in environmental factor.

C) Management factor. Initial management factor has the second and third level factors, but after full communication with field personnel, eventually secondary consolidation to the third level. 6 third grade factors are training, reward and punishment policy, quality of cadres, forced task, blind command and national policy.

Finally, identify factors of influencing coal mine "three violations": 3 primary grade factors, 6 second grade factors, 25 three grade factors [5,6].

2.2 Site Investigation. Questionnaire is widely adopted way of investigation, it adapts random sampling to determine samples, completes the research which designed in advance by investigators access to the samples, result of the survey is obtained by statistical analysis finally. 45 questions that contain all affecting factors are designed by repeatedly revising. Questionnaires are sent to 300 miners directly involved in production under support and organization of leadership, they fill in the questionnaire by on-site guidance and all recycled, effective examination paper is 289 and effective rate is 96.3%.

2.3 Questionnaire Reliability Test. The reliability of questionnaire, that is, credibility of the questionnaire, refers to result consistency degree while repeated measurement for same object in the same way, also is an extent of reflecting actual, the method of reliability estimation adopts Cronbach formula to calculate coefficient α [7].

$$\alpha = (\frac{k}{k-1})(1-\frac{\sum S_{i2}}{S_{x2}}) = (\frac{45}{45-1})(1-\frac{19.6256}{66.712}) = 0.7218 \quad (1)$$

Where, k is question number, S_{i2} is variance of a certain subject score; S_{x2} is variance of whole test score. Coefficient α calculated is 0.7218 > 0.70, shows that the questionnaire be useful.

3. Analysis of "three violations" influence factors of coal mine

3.1 Statistics of Influence Factors. Each question of questionnaire contains five options: very consistent, more consistent , uncertain , more inconsistent , very inconsistent, five options are assigned respectively when statistical analysis for questionnaire, very consistent is 5 score, followed by 4 score, 3 score, 2 score and 1 score, average score of three level factors could be got , but it can not be directly as a evaluation standard of the factors and need think about each factor proportion in all factors namely weight of every factor which using AHP to solve.

3.2 Analytical Hierarchy Process (AHP). Analytic Hierarchy Process (AHP) is a commonly used method in the decision making process. First, problem to be solved is layered series, namely according to nature of the problem and to achieve goal , the problem is broken into different component factors , the hierarchical clustering combination in accordance with interaction reflection and subordinate relationship between the factors to form a hierarchical and orderly hierarchical structure model . Then, give a quantitative representation for relative importance of each level of the factor model based on objective reality judgments of peoples', and then use

mathematical methods to determine weight of all factors of each grade. Finally, calculating relative importance weight of each layer to obtain relative importance weight between the lowest (measure layer) and top level (target layer), which as a basis for evaluation and selection program.

Yaahp (Yet Another AHP) is an analytic hierarchy process (AHP) software, there need to construct a reasonable AHP model hierarchy before using the software, analyze decision problems clearly, which is the need to sort out a hierarchical structure .Hierarchical model is constructed as follows:

Target level (top level): influence factors of coal mine "three violations";

Rule level (middle layer): analyzing the main reason of coal mine "three violations", summarized in three aspects: individual, environment and management;

Measure level (the lowest level): 25 three level factors of impacting coal mine three violations;

Yaahp software can be used in construct a judgment matrix after model constructing, while the assignment of importance is consulted many people who have experience cadres in coal mine, workers and teachers, by pairwise comparison with each element, degree of importance is assigned of 1-9 which be used in analyzing and comparing each factors of target and rule lever, rule and measure level, to determine a reasonable value, table 1 shows the importance comparison to each factor in management factors, others can be determined by using same method[8].

Table 1 Comparison of Importance in Management Factor

	national policy	reward and punishment policy	training	quality of cadres	blind command	forced task
national policy		1/4	1/5	1/5	1/6	1/7
reward and punishment policy			1/2	4	1/5	1/3
training				3	1/2	1/3
quality of cadres					1/3	1/3
blind command						2
forced task						

The weight value of each factor is calculated using yaahp software according to importance of each factor, and following in reliability of these weights should be tested. When CR <0.1 , the consistency of judgment matrix is considered acceptable , CR> 0.1 , it does not meet requirement and need to re-amend the judgment matrix.

The matrix consistency of cause of coal mine "three violations" accident, individual factors, environmental factors, management factors, individual factors, physiological factors, psychological factors, family environment, work environment and social environment are all less than 0.1 use software examination. Tested every consistency of judgment matrix is acceptable, so the weight is true and reliable.

3.3 Influence Factors Analysis of "Three Violations" and Countermeasure. Front have got average data by counting of each factor in questionnaire, the date multiply weight value calculated by yaahp software are weighing scores of all three lever factors[9], below only listing three aspects which psychological, operating environment, management in table2, table 3, table 4.

Table 2 Psychological Factor Score

Factor	Average data	Weight	Weighting score
Lucky	2.439153439	0.0232	0.056588360
Paralysis	2.433862434	0.0162	0.039428571
Habit	2.320105820	0.0476	0.110437037
Reckless	2.359788360	0.0332	0.078344974
Against	2.396825397	0.0113	0.027084127

Contrast data in table 2, you can see that weighting score of habit is 0.110437, in the first place, so it is most likely to lead to the essence of "three violations". The staff will have some habitual problem which tends to continue to work in future , even he is not sure whether there are "three

violations" behavior, therefore need to collect erroneous action and work habit that be emphasized in training , at the same time with negative education using accident caused by habit operation so that everybody could be alert; addition to safety rule is printed booklet distributing to each mine for comparing operation process rule with themselves, correcting their bad habit action and keep safety operation process in mind.

Second is foolhardy, the possibility of "three violations" behavior is larger while work blindly and regardless safety operation procedure. Fluky, paralysis, and against is follow and has lower score, but doesn't mean they don't cause "three violations", only the probability is lower.

Table 3 Operating Environment Factor Score

Factor	Average data	weight	Weighting score
Monitoring and protection facilities	2.671957672	0.0261	0.0098
Work equipment	2.382275132	0.0552	0.0232
Natural environment	3.095238095	0.0188	0.0061

It can be seen in table3, production equipment is the highest score in working environment, it is expressed that work equipment has a greater influence for happening "three violations" of underground miners and it must be checked regularly and make timely repair when have some problem, fault much too large even difficult to run the device must be replaced. In addition, production work equipment must have a clear color-coded such as warning sign of red, so that miner will be more simple and convenient to operate, thereby reducing accident probability in production.

Table 4 Management Factor Score

Factor	Average data	weight	Weighting score
Training	1.873015873	0.0989	0.18524127
Reward and punishment policy	2.817460317	0.0681	0.191869048
Quality of cadres	2.469576720	0.0437	0.107920503
Forced task	3.227513228	0.1615	0.521243386
Blind Command	3.058201058	0.2018	0.617144974
National policy	2.584656085	0.0196	0.050659259

It can be concluded from table 4 that the highest score is blind command in management factor, followed by forced task.

The weighting score of factors in three grades are obtained using the same method, drawing line chart and be shown in Figure 1. Blind command and forced task are the most important factors. So as the coal mine management should pay attention to these, when arranging tasks must be close to the real work ability of miner, work out reasonable task based on previous work data; besides coal mine must be careful in selecting manager who should be regular inspection and training to ensure remember security operating procedures every moment of the day; In the end, mine must provide that manager direct production according to the safe production process, not according to his own preference casually command.

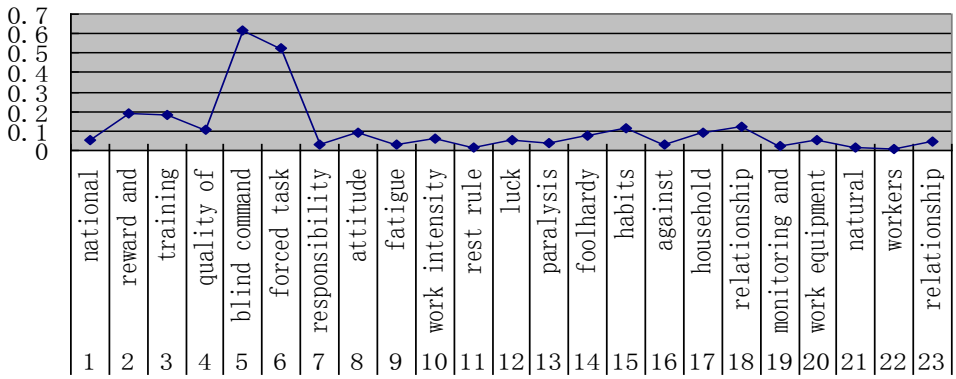

Fig. 1 Weighting score of three level factors

4. Conclusion

Author comprehensive analyzes cause of coal mine "three violations" behavior from the miners' psychological, physiological, working environment, management etc., by using method of questionnaire for specific mining investigation to ensure the authenticity and reliability of data source, the main factors of affecting coal mine safety is found by relying on yaahp software using analytic hierarchy process (AHP), it can be found the conclusion use this method more closer to actual by ditching with coal mine workers. Therefore, introducing analytic hierarchy process (AHP) into safety accident analyze can make the result more objective and reasonable.

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