# Study on Early warning model of Coal mining engineering with Fuzzy AHP

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**Abstract**

The safety issue of coal mining engineering is very important to coal industry. According to our coal mine enterprises' safe characteristics, this paper analyzed the risk factors of coal mining engineering and studied the safety problem of "human-machine-environment" system. The risk factors of coal mining engineering are divided to natural geological factors, personnel factors, equipment factors and management factors. Based on the fuzzy mathematics and these factors, the safety early warning model of coal mining engineering is constructed by using the fuzzy AHP method. Through the use of early warning model, we can find the risk sources and hidden danger of mining operations in time. Combined with a production mine, this early warning model is applied to the mining operations process. The results show that this early warning model is effective to prevent the accident.

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Keywords: coal mining engineering; safety early warning; Analytic Hierarchy Process; fuzzy mathematics

## 1. Introduction

Coal mine safety management is very important to coal mining engineering. Many research works about coal mine safety management are done by Chinese scholars and the coal mine safety management has been greatly improved in recent years. But according to the overall development level of coal industry, the Chinese coal mine enterprise management is in the empirical accident management stage and can't meet the practical needs by enterprise production actions. It is an urgent task to break island state of security information and excavate the valuable information from the feedback data of coal mining system[1]. Based on the fuzzy mathematics, this paper constructs a safety early warning model of coal mining engineering. Combining safety factors of coal mine, the safety early warning model can be used to improve safety management situation of coal mine enterprises.

The research object of safety early warning is "human-machine-environment" system. By using modern tools and technology, we can get all kinds of safety related data and carry out a series of activities such as assessment, review, classification, analysis and monitoring, etc. Then the security warning signals in different stages can be got[2]. Base on the risk signals are conveyed in time, we can get the safety data about coal mining engineering with the safety early warning model. By contrast wit the risk management threshold, we can adopt different control behaviors to avoid accidents.

The main activities of safety early warning about coal mining engineering include monitoring and identification of hazards, alert diagnosis and evaluation, warning decision, anticipating control and control, trend forecast and so

on. These activities can be divided into warning analysis and warning countermeasures. At first, by monitoring the hazards of production process, signals are collected from the external environment and each subsystem according to the monitoring indexes system. Through the analysis of the monitoring information, alert is identified. It means that we use appropriate identification index to estimate the alert that has happened and will happen. To the alert happened we can make the diagnosis and evaluation and forecast the development trend and harm degree. Then the corresponding control measures can be adopted[3].

## 2. The safety early warning model of coal mining engineering

The safety early warning model of coal mining engineering includes many indexes. And each index includes lots of related factors. To these factors, some can be quantitative expression and some can only be qualitative expression. So we can combine Analytic Hierarchy Process (AHP) with fuzzy comprehensive evaluation approach to get the safety early warning model of coal mining engineering. The multi-grade fuzzy comprehensive evaluation about quantitative index together with qualitative index can be achieved.

The Analytic Hierarchy Process (AHP) is a structured technique for helping people deal with complex decisions. The AHP can help we deal with qualitative problems with quantitative analysis method.

① Each index in system should be resolved into several levels. Every index at the same level is subject to the upper index and governs the lower index. Then a hierarchical structure model about the problem can be constructed.

② The relationship of indexes in system should be analyzed. With a rule, one index should be compared with another index at the same level about the importance to the upper index. Then a comparison matrix about the comparison process can be got.

③ The weight of every index can be got with the comparison matrix based on the rule and the consistency of comparison matrix should be tested. Then with weight of indexes, the total arrangement weight of the level to system can be got.

### 2.1. The evaluation grade set of safety early warning model

The evaluation grade set of safety early warning model is a qualitative description about safe state of indexes. The safety class Is divided into 5 grades in this paper and the evaluation grade set is V= {$v_1$, $v_2$, $v_3$, $v_4$, $v_5$} = {very safe, safe, common, risky, very risky}.

### 2.2. The warning monitoring index set of safety early warning model

Combined with security theory of coal mining engineering and actual situation of the coal mine, the warning monitoring indexes system consists of geological environment, human, equipment, working condition, management. Each warning monitoring index consists of some junior index[4]. For example, the environmental monitoring index is composed of average wind speed, the supply-demand ratio of air flow, the minimum pedestrian elevation of mine workings, the minimum pedestrian width of mine workings, temperature, dust concentration, the qualification rate of mine workings. Based on the warning monitoring indexes system, the warning monitoring index set is U= ($U_1$, $U_2$, $U_3$, $U_4$, $U_5$) that is corresponding to geological environment, human, equipment, working condition, management. The index $U_i$ is composed of the lower index that is mean $U_i$= {$U_{ij}$}, j=1, 2,…, n.

### 2.3. The weight of index