

Visual Analysis of Miner Safety Research Based on Knowledge Graph

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Abstract: In order to better understand the current research status and development trends in the field of miner safety, with the help of CiteSpace analysis tools, 450 papers on the safety of miners from core publications and above in the CNKI database from 1992 to 2020 conduct bibliometric analysis. The results found that the main research content of current miner safety can be roughly summarized into six aspects, including coal mine production and management, miner safety quality, physical and psychological research methods. In the future, in the research of miner safety, it is necessary to adhere to the combination of theory and practice, and multi-disciplinary integrated research, to provide deeper and more comprehensive protection for miner safety.

1. Foreword

There are many risks in the coal industry, and it is also the foundation of our national economy and an important guarantee for social production and life [1]. In recent years, the safety situation of my country's coal enterprises has continued to improve, but compared with developed countries, there is still a big gap [2]. There are still many coal mine accidents in China every year, and the death rate per million tons is much higher than that of developed countries.

The key to safe production lies in people [3]. Miners are high-risk occupations, the hard working environment, complex production conditions and various potential safety hazards in coal mines pose a great threat to the lives and health of miners. In order to better guarantee the safety of miners and carry out safe production, the academic circle pays more and more attention to the safety research of miners, so the safety research of miners also increases. In order to better understand the current research status and development trends in the field of miner safety, this paper conducts a visual analysis of the literature on mining safety based on knowledge graph software.

2. Data source

This article uses "miner safety" or "coal worker safety" as the subject, and searches the CNKI database from 1992 to 2020. Select the journals whose source category is the core and above, and get a total of 464 journal articles. In order to ensure the representativeness of the data, the news, conference notices, reports and irrelevant documents that did not meet the conditions were manually removed, and a total
of 450 journal documents that could be used for analysis were finally obtained and saved as Refworks format.

3. Visual analysis based on knowledge graph

It mainly uses the CiteSpace knowledge graph analysis tool to visually analyze the literature on mining safety. Through the intuitive knowledge map, you can show the development dynamics of a subject in a certain period, so as to obtain information such as a certain research hotspot, and gain insight into the evolution process of research[4][5].

3.1. Keyword co-occurrence analysis

Keywords are the author's highly refined and generalization of the core content of the article, reflecting the value and direction of the article's research. Keywords with high frequency are generally used to represent hot topics in a certain research field[6]. Run CiteSpace to get a co-occurrence map of keywords in the field of miner safety, as shown in Figure 1.

In Figure 1, the number of nodes N is 361, the number of connections E is 668, and the density is 0.0103. It can be seen that the overall degree of linkage between keywords is relatively small, and there are relatively more linkages between keywords in small areas. On average, there are 3 keywords associated with an article. By merging keywords, keywords that appear frequently are obtained: miners (94), unsafe behaviors (67), safe behaviors (59), structural equation modeling (44), coal mines (36), impact Factors (33), unsafe psychology (31), safety perception (28), job burnout (26), safety atmosphere (22). In the research on the safety of miners, unsafe behaviors and safe behaviors are the most studied, so the research focus is on the behavior of miners and their physiological and psychological states.

3.2. Keyword cluster analysis

In order to show the research hotspots in the field of miner safety more comprehensively and intensively, cluster analysis is introduced for in-depth research on the basis of keyword co-occurrence analysis. Use CiteSpace to cluster keywords and use the LLR (log-likelihood ratio) algorithm to obtain 14 cluster groups, sum up 8 large cluster groups: 0 miners, 1 unsafe behavior, 2, system Kinetics 3, 4 psychological quality, 5 safety atmosphere, 6 leadership style, 7 influencing factors, 8 emotional problems. The clustering module value Modularity Q=0.7106>0.3 means that the clustering structure is significant, and the cluster average contour value Silhouette=0.9041>0.5 means that the clustering is reasonable.
By analyzing the keyword clustering map in Figure 2 and sorting out the literature, the main research content of miner safety is roughly summarized into the following six aspects:

1. In terms of coal production. In the production process of coal mines, the coal mine environment has a great impact on the safety of miners. If improperly controlled, gas explosions may occur and cause casualties. The confined space in the coal mine provides a prerequisite for the explosion. Excessive temperature and noise in the coal mine will also affect the physiological indicators of the miners.

2. Coal mine management. Management itself is to make the work better and more effective. However, various factors in the management process may have certain deviations, resulting in the work cannot be completed safely and effectively. Organizations, managers and managers, leadership behavior and safety culture will affect the safety behavior of miners.

3. Safety quality of miners. The study found that in addition to the influence of external conditions, the safety quality of the miners themselves also has a certain impact on the safety of the miners. For example, emotional intelligence, safety awareness, risk perception, safety attitude and attention will all significantly affect the safety behavior of miners.

4. Physiological aspects of miners. In the safety of miners, the research on the physiology of miners is mainly divided into two points. One is the occupational diseases of miners and some physical injuries caused by work.

5. Psychological aspects of miners. In the safety of miners, the research on the psychology of miners is mainly divided into two points. One is the influence of work on the psychology of miners; the other is related research on unsafe behavior of miners due to psychological factors.

6. Research methods related to miner safety. At present, the most used research method is to build models for simulation, evaluation and prediction, and use the model to study the factors affecting the behavior of miners, unsafe behaviors and accidents. In recent years, experimental research has also begun to slowly appear. The use of psychological experimental instruments to study the safety of miners can achieve multidisciplinary integration. Some scholars began to use EEG, eye movement and other experiments to conduct more diversified research on the safety of miners.

4. Conclusion
Through the use of CiteSpace software to analyze the core and above-level documents published in the field of domestic miner safety in 1992-2020, the following conclusions are obtained:
1) The analysis of keywords shows that at present, more scholars in the research on the safety of miners have shifted their focus from the study of the external environment to the study of the miners themselves, focusing on the impact on the behavior of the miners from an artificial perspective. At present, the main research content of miner safety is roughly summarized into the six aspects of coal production, management, safety quality of miners, physiology and psychology, and related research methods. Through the integration of the six aspects and the co-occurrence of keywords it can be found that the current research hotspots are the behavior and physiological and psychological state of miners.

2) Most of the relevant literature is mainly aimed at solving practical problems, and theoretical research is the secondary purpose. The dangers faced by coal mine workers are much higher than those in other industries. Therefore, the safety of miners has received more attention. In the research, more scholars are committed to improving the safety environment of miners, and from all aspects of the factors affecting the safety of miners, excavation, in-depth interviews with miners in coal mining companies, questionnaires, etc. to obtain more realistic and representative information, analysis and modeling, etc. to study the factors affecting the safety of miners, and propose corresponding suggestions for coal management reference.

3) Realize the integration of multi-disciplinary research. The research on miner safety includes the content of safety management discipline, and because the main research object is miners, human factors engineering is also introduced as an interdisciplinary subject. Related knowledge such as management and safety science is also applied. In the research process, it is found that Human psychological and physical conditions will affect the safety of miners, so physiology and psychology related knowledge are also used. In the research of miner safety, related content of multiple disciplines is introduced, so it belongs to multi-disciplinary research.

Fund information
This article is a general project of the National Natural Science Foundation of China, 《Research on Recognition and Simulation of High Probability Nearly Ominous Events in Coal Mines under the Horizon of Multi-source Information Fusion and Hesitating Fuzzy Decision-making》 (51874237) and the National Natural Science Foundation of China's key support project 《Major coal mine disasters concealed disaster One of the phased achievements of "Research on Factor Risk Identification, Early Warning and Emergency Management》 (U1904210).

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