Application and Analysis of Decision Support System in the Development Trend of Coal Science and Technology

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Abstract. This paper expounds the development of coal technology in China, points out the development of safe and efficient production technology and equipment in coal mines, and the research of coal production technology and equipment. It also explains the decision support system and its related technologies. By combining with the development of coal science and technology, the article mainly studies the current situation of coal science and technology development and compares it with the traditional information management system. The result shows that the reduction rate of energy consumption per unit output value of the decision support system in coal is 5% higher than that of the traditional information management system, It also shows that the decision support system can be suitable for decision-making of coal enterprises, and is conducive to the development of coal science and technology.

Keywords: Application Analysis; Development Trend; Coal Technology; Decision Support System; Information Management System.

1. Introduction

Coal mine is the pillar industry of the national economy, the lifeline of the national economy, the important pillar of the national economy, and the important support for the sustainable and healthy development of the national economy. In China's primary energy consumption, coal accounts for 72%. For a long time to come, coal will still be the main energy. Coal science and technology is the key to the development, safe, clean and efficient use of coal resources, and to promote the healthy and sustainable development of coal industry.

Universities and production units should strengthen production, study, research and application, actively promote technological innovation, and make major breakthroughs in basic theoretical research, key technology research and development, major equipment research and development, promotion and application, which has promoted the rapid development of coal technology. The development of China's coal industry has encountered many new problems and challenges. Therefore, it is necessary to strengthen scientific and technological innovation of coal, strengthen scientific and technological support, enhance the technical capabilities of coal enterprises and enhance their core competitiveness.

2. Related Work

Coal is an important mineral energy in China. The development of coal science and technology is conducive to the development and utilization of coal. The decision support system has also been studied by scholars on the research of coal science and technology. Coal is an essential fossil fuel in China; However, coal mining and utilization are facing increasing ecological and environmental protection pressure. Wang Guofa analyzed the development trend of China's coal chemical industry 3.0 and put forward technical support and strategic guidance for the transformation from traditional coal to clean energy [1] based on its policy recommendations on China's coal chemical industry 4.0 and 5.0. Falshtynskyi V carried out research on the development of coal reserves through the analysis

of underground gasification technology, the analysis and research of thermal and mass balance gasification process parameters, the determination of the stress and deformation state of the rock mass around the gas gasifier and the operation of its technical and economic indicators, and found that the new gasification coal reserve technology can use additional non-commercial and abandoned coal reserves, and extend the duration of mining enterprises [2]. Coal mine methane (CMM) is an important unconventional natural gas with a global reserve of 2.6 × 1014m3. However, most low concentration coal mine methane (LC-CMM) is not utilized and directly discharged into the atmosphere, generating about 28 billion m3 of CH4 emissions annually, and causing serious greenhouse effect and energy loss. In this regard, Wang Xinxin reviewed the latest progress of LC-CMM utilization technology in low concentration emissions and ventilation air methane, and particularly introduced the huge progress of LC-CMM application in China [3]. However, the application of coal energy support decision system is relatively small, so scholars have explored the support decision system.

Decision support system can reasonably help people make intelligent decisions, which is also called human-machine intelligence system. Decision support systems are also used in various fields. Computerized clinical decision support system (CDSS) represents the paradigm shift in the field of medical care. CDSS is used to enhance the complex decision-making process of clinicians. Sutton Reed T. gave the latest overview of the application of clinical decision support systems in medicine, including descriptions of different types, currently proven use cases, common traps and potential hazards [4]. Scholars have also studied the support decision system, but it has not been used in coal. For this, the paper explains the impact of the decision support system in coal.

3. Application of Decision Support System in Coal Science and Technology

3.1 Decision Support System and Related Technologies

Decision support system (DSS) is a computer-aided system that takes management information system, management science/operational research as the core and uses computer, simulation, information technology and other technologies to provide decision support for decision problems [5-6]. DSS is a research method that combines management and operation, organically combines massive data and multiple models, and supports decision-making in human-computer interaction. This is the initial stage of DSS, which can also be called the initial DSS.

The core of the management information system is to process massive enterprise data. Its primary task is to use modern computer and network communication technology to strengthen information management, collect data, collate, collate and produce various information, so that managers can make appropriate decisions and implementation. The research of management science and operational research is based on the design model to provide decision support for managers.

The purpose of DSS is to help decision-makers make reasonable decisions through human analysis and judgment, computer and scientific means, so as to obtain the most satisfactory results. The functions of DSS vary according to their functions, and the differences in their functions also determine the differences in their purposes, which are reflected in the efficiency of DSS, not the improvement of efficiency, as well as the adaptability to users. As an environment and tool to support the decision-making process I, it should have variability, give priority to practicality, put potential technology in a secondary position, and attach importance to policy makers rather than replace them.

Data warehouse technology. Data warehouse technology refers to a kind of data that is subject-oriented and relatively stable to reflect the historical evolution process. Its role is to provide a reasonable organization and management method for the accessof massive data. In the future development of relational database, distributed technology and parallel processing technology, data warehouse has become an important research direction. It can not only store massive data, but also efficiently manage massive data like a warehouse, providing more objective information for decision support systems and project management.

Data mining technology. Data mining technology organically integrates database technology, artificial intelligence, pattern recognition, statistics, data visualization and other theories [7-8]. Data mining technology extracts from massive, chaotic, uncertain and potentially valuable data. Ant colony algorithm in data mining can be expressed as:

$$Q(t^2) = -\sum_{i=1}^{n} P(t)\log P(t) \quad (1)$$

$$P(t) = \frac{t}{n} \quad (2)$$

Data mining technology is widely used in large-scale supermarkets, banks, transportation, insurance and other commercial activities. The structure steps of DSS are shown in Figure 1.

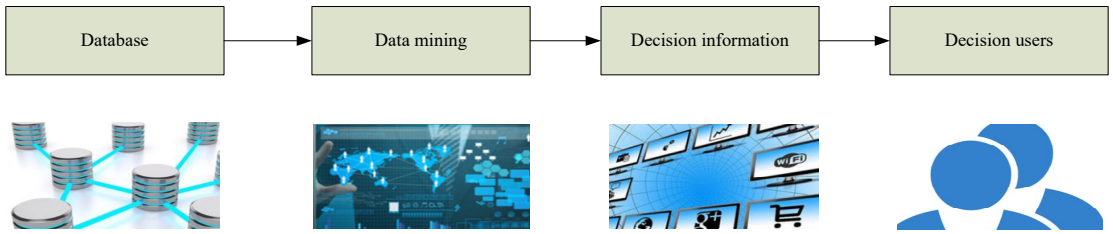


Figure 1. Structural steps of DSS

3.2 Problems in the Development of Coal Industry

Under the new economic situation, coal mining enterprises are in urgent need of transformation and upgrading. Over the past decade, China's economic growth has shifted from the previous high speed of about 10% to the medium-high speed of 7% - 8%, and the economic development has entered a new normal, that is, the coal industry has increased by 200 million tons per year over the past decade, and the average annual growth rate has reached 10%. Affected by many factors, such as the slowdown of demand growth, the advance of capacity construction, and the expansion of the area affected by imported coal, the coal price has dropped significantly. At present, China's coal mining enterprises are facing increasing losses, and coal mining enterprises above the coal mine scale have generally suffered losses [9-10]. At the same time. At the same time, coal mines are also facing serious challenges in energy conservation and emission reduction, haze control, environmental protection and other aspects. The coal industry has entered a new economic normal, the growth of demand has slowed down, and the extensive development mode of the coal economy has become unsustainable. It is necessary to change the development mode and accelerate the structural adjustment and transformation of the coal industry. The energy revolution is changing the mode of coal production and consumption. With the enhancement of environmental awareness, countries around the world are accelerating the structure of clean energy. The United States, Japan, Europe and other developed countries have accelerated the adjustment and optimization of the energy structure and vigorously developed the new energy industry.

Vigorously develop "low-carbon technology", enhance China's energy technology innovation capacity, occupy a leading position in the new round of energy revolution, and obtain greater advantages in energy technology and technology [11-12]. In order to meet the needs of energy development at home and abroad. To promote the energy revolution, coal is the main energy in China. We should start with the development mode, improve the coal production and consumption mode, and increase technological innovation to promote the mechanization, informatization, intelligence, and green development of coal production, promote the energy saving, clean, low-carbon, and efficient development of coal consumption, realize the transformation of coal from fuel to raw materials and energy, and promote the green and low-carbon development of coal industry.

The development strategy driven by innovation will promote the development of coal technology. At present, China's coal industry is in an important period of structural adjustment, structural adjustment, transformation and upgrading, and reform. The fundamental way out for development is

to take innovation as the driving force. On the one hand, due to the huge consumption of coal resources, haze often occurs in some regions, the scope of influence is becoming wider and wider, the cumulative negative impact of environmental pollution is becoming more and more obvious, and the resource and environmental constraints tend to be strengthened. Therefore, it is necessary to improve the efficiency of resource utilization and promote the new model of green and low-carbon cycle development of coal through innovation-driven. On the other hand, with the gradual loss of the advantage of low price of production factors, the continuous rise of labor prices, and the change of the supply and demand pattern of land resources, it is difficult to support the economic development with large-scale and high-intensity input of production factors, and it is necessary to rely more on scientific and technological innovation to improve quality and efficiency, so that scientific and technological innovation becomes a new driving force for the development of the coal industry.

3.3 Development Trend of Coal Science and Technology

China should further strengthen the support of science and technology, and gradually form a technological innovation system of coal industry with enterprises as the main body, market as the guidance, and the combination of production, education and research. To solve a number of key technical problems that restrict industrial development, we must strengthen scientific and technological innovation. The development of coal mining technology has the following aspects.

Large mine construction under special geological conditions. With the continuous transfer of China's coal resources to the west, the western region is characterized by large scale, many inclined shafts, large shaft diameter, weak formation cementation and instability. At present, China's special drilling technology cannot fully meet the geological conditions of the western region, and the freezing technology of inclined wells is also a blank. At present, it is urgent to carry out in-depth research on inclined shaft freezing technology, soft rock drilling technology and vertical shaft mechanical hole construction technology to adapt to the rapid construction of large diameter mines. In order to improve the driving speed of rock roadway, it is necessary to carry out the whole rock roadway driving machine, drilling and blasting method driving equipment, hard rock cutting method, and roadway driving dust prevention technology.

Rational use of coal resources. Efficiency and intensification have become the main trend of the development of China's coal industry, but there are still large differences in safety, automation and other aspects between the current medium and high-end mining equipment. In addition, due to the current low level of comprehensive mechanization in small and medium-sized mines; In addition, most of the equipment of large and medium-sized open-pit mines rely on imports, so it is urgent to improve the domestic equipment technology level. It is necessary to carry out scientific and technological research on the reliability, automatic control, soft start, new high energy consumption battery, high power explosion-proof diesel locomotive and other aspects of the comprehensive mechanized mining device in the mine. At the same time, it is also necessary to carry out extensive research on the national slope comprehensive disaster reduction decision-making system, slope disaster control theory and equipment.

The modernization of mines is the focus of governance. Informatization and the Internet of Things are industries that China vigorously develops and supports. Mine information monitoring is the guarantee of mine safety. At present, the reliability and timeliness of the modernization construction of the mine are poor, and the comprehensive control of the mine production process is lacking, and the locking of human-computer interaction cannot be achieved. Therefore, exploration must be carried out in the technical fields of mine integrated control, coal mine Internet of Things technology development, mine integration and communication, so as to achieve the goal of connecting people and things, data exchange, emergency linkage and disaster prevention in the future under the global resource conditions, The development and research of the coal industry, the new accounting standards for the development of China's coal industry, the cost control of coal mines based on the Internet of Things, the construction of key reserve bases for the development of China's coal enterprises, and the coal mine safety training technology are all urgent problems to be solved.

Comprehensive utilization of coal and coalbed methane resources. Although China has a large number of coalbed methane resources, its development conditions are complex, the extraction is difficult, and the extraction potential is also weak. Under the conditions of different coal ranks and different depths, the enrichment and accumulation laws of CBM in CBM are also urgently needed; It has developed multi-branch directional deepwater horizontal well technology, protective coal seam mining, borehole wall fixation, layered continuous fracturing technology, coalbed methane low-temperature gathering and transmission technology and monitoring technology; Research and development of key technologies and devices such as efficient utilization of coalbed methane, and key technologies such as comprehensive utilization of coalbed methane resources. The connection between the development of coalbed methane and mine construction has been further strengthened. Under different occurrence conditions, the coordinated development of coalbed methane research and mining has been carried out, providing advanced technology and equipment for the industrial production of coalbed methane.

Prediction and prevention of dynamic disasters in coal mines. With the expansion of mine scale and the change of mine production environment, the risk of mine gas outburst is increasing. Natural fire, gas, coal dust and other thermal disasters occur frequently, and major outburst accidents have not been effectively controlled. In view of the characteristics of dynamic disasters in coal seams, the multi-factor coupling mechanism of dynamic disasters in coal seams, the detection and monitoring of precursor information, the comprehensive prevention and control technology of coal and gas, and the detection technology of hidden fire sources are mainly studied in order to establish and improve the technical system of dynamic disaster prevention and control in coal seams and improve the level of comprehensive prevention and control technology.

The coal mine emergency rescue work urgently needs highly reliable search and rescue and detection technology, large-diameter life-saving equipment and life-saving equipment, rapid installation of large-flow drainage equipment, large-capacity underground mobile refuge equipment, fixed refuge chambers and personal protection equipment; Develop a computer-aided decision-making system that can quickly make rescue plans

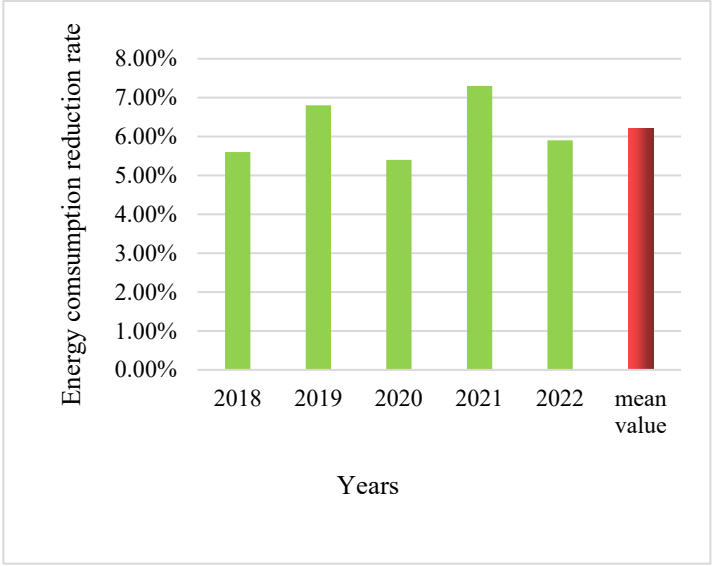
And on this basis, a mine safety production management standard that conforms to China's national conditions and the characteristics of the coal industry is constructed. The dust pollution prevention and control technology is mainly studied, and the dust early warning, dust concentration sensor, dust real-time monitoring and other technologies are mainly discussed. With the development of the mine, the surface temperature is rising, and the heat source in the mine is mainly the heat release of mechanical equipment. Therefore, there are a large number of heat-damaged mines in coal mine production. At present, due to the low integration of low-temperature technology and equipment in China, low refrigeration efficiency and high operating cost, the research and development of heat hazard prediction and control technology and equipment have been carried out in deep coal mines.

Conversion of coal treatment quality and cleaning efficiency. Clean utilization of coal is an important measure for environmental protection and active response to global climate change. Coal washing, upgrading of low-grade coal and production of coal-water slurry are important basis for clean utilization of coal. The development of coal clean conversion technology is the clean utilization of coal resources, the key to the adjustment of coal industrial structure, the implementation of the Western Development, and the guarantee of national energy security.

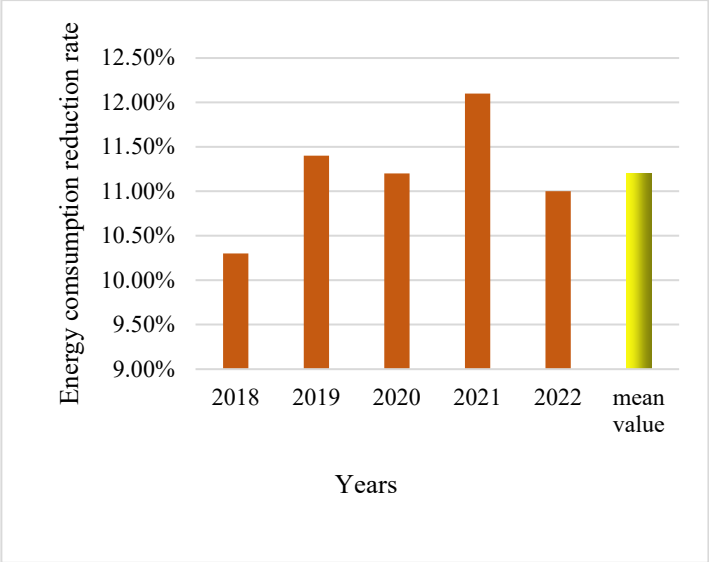
4. Coal Development based on Decision Support System

In this paper, by comparing the decline rate of energy consumption per unit output value of coal enterprises based on the decision support system and the traditional information decision system, and by inputting all aspects of data and information of the enterprise into the computer system for simulation, the decline rate of energy consumption per unit output value of coal enterprises under different decision systems can be obtained. The more energy consumption decreases, the more superior the decision-making system is, and can reduce enterprise losses. This paper mainly inputs

the coal mine data information of the enterprise from 2018 to 2022, and compares its average energy consumption decline. The energy consumption decline based on the decision support system and the energy consumption decline rate of the traditional information decision system are shown in Figure 2.



2A: Energy consumption reduction rate of traditional information decision-making system



2B: Decline rate of energy consumption of decision support system

Figure 2. Energy consumption reduction rate of the two systems

It can be seen from Figure 2A that the energy consumption reduction rates in 2018-2022 are 5.6%, 6.8%, 5.4%, 7.3% and 5.9% respectively, with the average energy consumption reduction rate of 6.2%. In Figure 2B, the energy consumption reduction rates in 2018-2022 are 10.3%, 11.4%, 11.2%, 12.1% and 11% respectively, with the average energy consumption reduction rate of 11.2%. It can be seen that the energy consumption reduction rate based on decision support system is 5% higher than that of traditional information decision-making system, It also shows that the decision support system can reduce the energy consumption of coal enterprises and improve the output value of coal in the same unit in coal science and technology.

5. Conclusion

At present, coal resource is an important energy source in China, and coal science and technology are also valued by people. This paper mainly analyzes the development trend of coal science and technology through decision support system, introduces the relevant technologies of decision support system, explains the problems and development trend of current coal industry development, and analyzes the coal development through decision support system, Compared with the traditional information management system in terms of energy consumption reduction rate per unit output value, the result shows that the energy consumption reduction rate of coal enterprises based on the decision support system is higher, which is conducive to reducing enterprise losses and enhancing the development of coal enterprises. The inadequacy of this paper is that the decision support system is not designed in detail, and there may be data errors. With the development of science and technology, decision support systems will also be carried forward in various fields.

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