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Research on risk management and prevention and control system of major disasters in coal mine based on fish-bone diagram and STAMP/STPA model

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Abstract: *Fishbone diagram and STAMP/STPA model is a problem of control safety from the perspective of system theory, caused by the lack of sufficient control and safety-related constraints. There is a certain relationship between the model and coal mine construction projects. Based on the introduction of the basic concepts of the fishbone diagram and the STAMP /STPA model, this paper combines the construction of coal mine projects in China with frequent accidents, and based on the fishbone diagram model, establishes a coal mine stamping accident cause model. At the same time, the empirical analysis of typical rock burst accidents is carried out, and the starting point of the analysis is the theoretical point of view caused by system accidents. According to the fishbone diagram and STAMP /STPA model, the accident process is analyzed, the cause of the accident is analyzed, the accident disaster is described, and the safety constraints and fault behaviors are identified. Finally, the basic causes of the accident are analyzed and compared. The results show that the fishbone diagram and the STAMP /STPA model can be well used in the risk management of major disasters in coal mines. Through the safety control structure of the risk control model, the constraints and failure behaviors of each control level can be effectively identified. According to the interaction and feedback at all levels, the cause of the accident can be analyzed and obtained, which is of great significance for preventing and controlling major disasters in coal mines.*

Keywords: *major disaster, rock burst, risk identification, risk assessment, risk control, emergency management capability*

1. Introduction

China has a vast territory and rich ore resources. With the increasing progress of my country's mining technology, the development of the coal mining industry is getting faster and faster, and the depth and intensity of mining are also increasing[1]. Although the economy has developed rapidly, the occurrence of rock burst disasters has become more and more frequent during the mining process. If rock burst occurs during the mining process, it will bring huge losses to the mine, including casualties, mechanical damage, and mine collapse, which will seriously affect the normal operation of the mine. Coal mine rock burst refers to the dynamic phenomenon of sudden and severe damage caused by the instantaneous release of elastic deformation energy of coal (rock) mass in coal mine roadway or work, which is often accompanied by instantaneous displacement, throwing, Loud noises and air waves, etc[2-3]. If the sum of the static load in the coal and rock mass and the dynamic load caused by the mine earthquake exceeds the minimum load that induces the impact of the coal and rock mass, an impact disaster will occur. The earliest rock burst accident occurred in China was the rock burst accident in Fushun Shengli Coal Mine in 1933[4-5]. With the continuous increase of mining depth and scope, many mines across the country have experienced rock bursts one after another, and there is no perfect equipment to accurately predict when rock bursts will occur, which makes the damage of rock bursts more prominent[6].

The research on rock burst began in South Africa. Because rock burst has brought great harm to the safety of local mines, in order to reduce this loss, local experts began to conduct professional analysis on the factors affecting rock burst and preventive measures[7]. Therefore, South Africa specially set up the Nafei Mine Impact Committee to analyze the rock burst. With the development of technology, there are more and more places where rock burst occurs, and it has become a common hazard affecting mine safety, and the number of occurrences has become more and more frequent, bringing huge economic

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losses to various countries. To this end, Germany and the former Soviet Union have also established rock burst research departments and achieved great results. They have found their own methods for rock burst. The drilling cuttings method was invented in Germany to detect rock burst. According to the occurrence conditions and factors of rock burst, a corresponding preventive method—deep hole pressure relief measures was invented. In the analysis of the influencing factors of rockburst, Poland has also made great achievements[8]. In the middle of the last century, in order to deal with the hazards of rockburst, Polish experts carried out profound research on rockburst, and successfully created a Microseismic monitoring of rock bursts is used to prevent rock bursts. The research on rock burst in my country is relatively late, it only started in the last century, but with the rapid development of my country's economy, our experts have also made major breakthroughs in the research on rock burst. The influencing factors and occurrence conditions have been deeply understood, and corresponding prevention plans have been made according to the actual situation of the mine, which has greatly maintained the normal and safe production and operation of the mine, and reduced economic and property losses from all aspects.

2. Introduction to Models and Methods

2.1. Fishbone diagram analysis

The fishbone diagram analysis method was invented by the Japanese management master Mr. Ishikawa Xin, also known as the Ishikawa diagram analysis method. It is a method of discovering the "root cause" of a problem, also known as a "causal diagram"[9]. The characteristics of the problem are always determined by some factors. Find these factors through brainstorming, organize them together with the characteristic values according to their correlation, and arrange them clearly, and mark the graph of the important factors. It is called a characteristic factor diagram. Because of its shape like a fishbone, it is also called a fishbone diagram. It is an analysis method to see the essence through the phenomenon[10]. At present, the fishbone diagram is widely used in the manufacturing industry. In the analysis of problems in the manufacturing industry, it is mainly summarized from the aspects of man, machine, material, method and environment, which is conducive to a comprehensive analysis and discussion of the problem, the real cause of the problem, solve and improve, as shown in Figure 1.

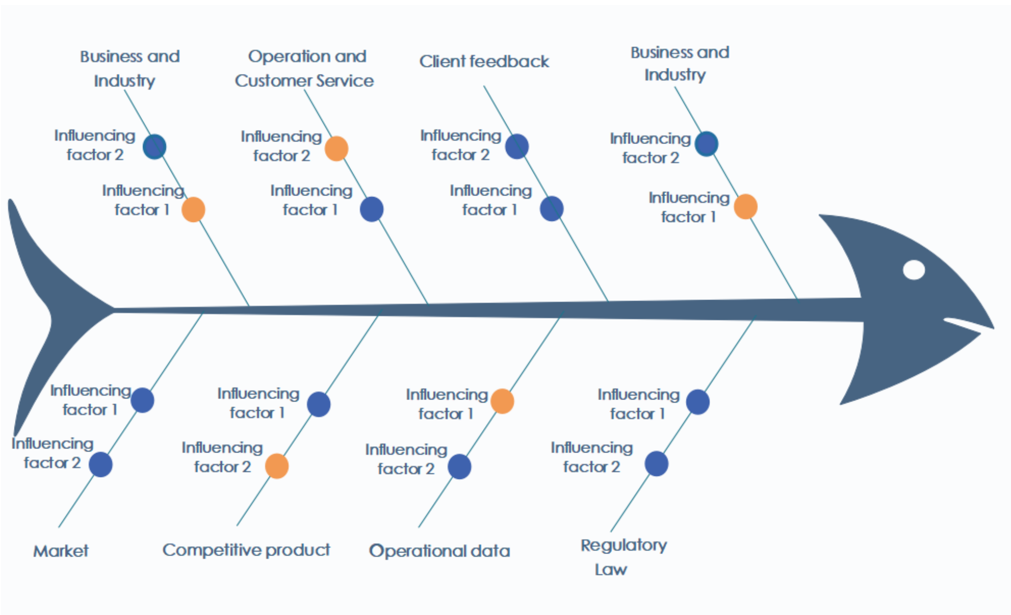

Figure 1: Fishbone diagram analysis model

2.2. STAMP /STPA Risk Control Model

STAMP model was proposed by Leveson in 2004. Although this model is suitable for the safety analysis and control of modern complex human-software-hardware systems, it is still insufficient in quantitative analysis. In view of this, in view of the systematic and quantitative challenges faced by the safety analysis of complex systems, the author proposes a method combining STAMP systematic

ISSN 2706-655X Vol.4, Issue 5: 86-95, DOI: 10.25236/IJFET.2022.040514

analysis and Bayesian network to analyze rockburst risk indicators from a control perspective. The STAMP method can define the safety control structure according to the characteristics of the rock burst accident, and analyze its unsafe control behavior and potential risks in detail; while the Bayesian network can use the systematic analysis results of the STAMP model as a guide to quantitatively analyze in detail System risk indicators; finally put forward suggestions or opinions to provide reference for evaluating the security of complex systems and establishing emergency plans. STPA (system—theoretic process analysis) is a systematic safety assessment method based on STAMP, by constructing a feedback control loop composed of controllers, actuators, control processes and sensors. The steps are[11]: ①defining the system risk; ②identifying and analyzing the relationship between the various components of the system; ③identifying inappropriate control behavior; ④analyzing the cause. The STAMP safety concept is: to prevent accidents, it is necessary to identify and eliminate or mitigate risk factors. The key is to discover and analyze unsafe interactions between components, so that the analysis results can be applied to all stages of system development, design, and operation, and to strengthen relevant controls, strengthen the relevant security constraints[12]. The STAMP /STPA risk control model considers that accident causes are generally divided into three categories, namely controller operation, behavior of actuators and controlled processes, and communication and feedback between managers and management, as shown in Figure 2.

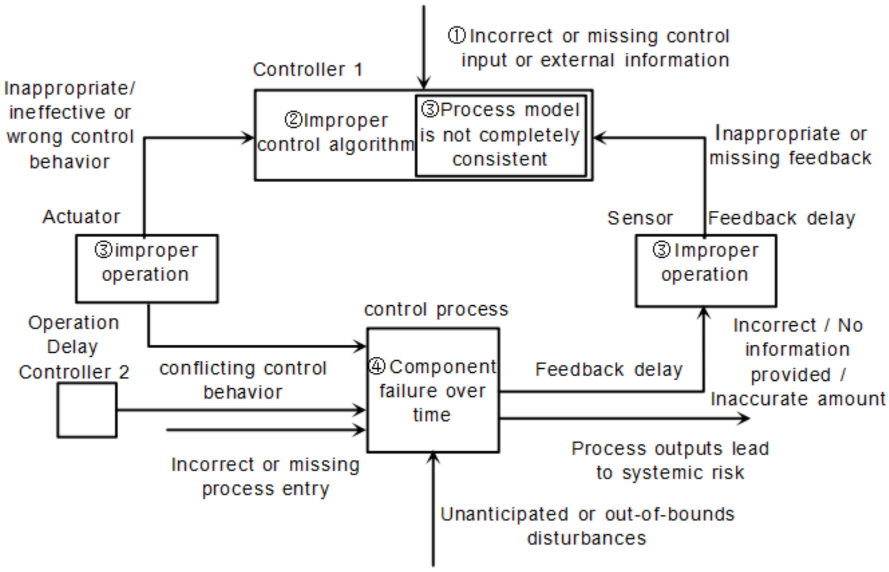

Figure 2: STAMP /STPA risk control model

STAMP /STPA risk control model has been well used in aerospace engineering, health care, and traffic safety. In this paper, we try to use the STAMP model to analyze the rock burst accident in Shandong Huafeng Coal Industry, and analyze the defects that lead to the accident from three different control aspects. In addition to technical reasons and unintentional or unintentional violations of regulations by workers, it is also necessary to discover errors in other agencies and their connections with each other. The key reason for the errors between these mechanisms is that the feedback loops between the layers in this hierarchical control mechanism of the system change after changes outside the system. All in all, the coal mine accident is a major production accident in our country, and it is eager to provide a wider and more systematic perspective, so as to help find and identify various safety hazards faster and minimize the possibility of accidents.

3. Risk analysis of major disasters in coal mines—Taking rock burst as an example

3.1. Project Overview

Huafeng Coal Mine is a typical representative of rock burst accidents. Since the first accident occurred in March 1992, more than 100 accidents have occurred in the mine. The main reason is that the coal seam has a strong tendency and the integrity of the roof coal seam is weak. The compressive resistance is weak, and the coal seam on the floor has strong integrity and compressive resistance. When the working face is subjected to concentrated stress, the roof will be bent and deformed, and conglomerate activities will occur, resulting in rock burst accidents. Therefore, combined with the

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actual situation and data of Huafeng Coal Mine, this paper analyzes the main causes of coal mine accidents, and puts forward some plans to prevent rock burst accidents and emergency rescue measures when accidents occur.

Huafeng Coal Mine is one of the large coal-producing areas in my country, with abundant coal reserves, and its 4th and 6th layers are the main coal mining areas. The probability of shock accidents in the main coal mining area is high, and it does not have stable safety. Other coal seams are relatively stable and are temporarily in a safe area. However, as the excavation depth increases, the surrounding rock exerts greater pressure, which is also dangerous. Although Huafeng Coal Mine has superior output, it also has frequent rock burst accidents. After many shock accidents, the relevant regulatory authorities have investigated and rectified the existing hidden dangers. The coal mine has also added a forecasting method that can predict the danger in advance. In order to disperse the pressure, there are also control measures such as blasting and drilling pressure relief. These measures are the result of discussions by coal mine staff and professionals, coupled with a technically advanced team. To a certain extent, it improves the safety factor of coal mining.

Since March 8, 1992, Huafeng Coal Mine has suffered more than 100 damage and rock bursts in the mine, and 4 very serious casualties have occurred, resulting in a total of many deaths. This seriously affected the normal safety production order in the mine, disrupted the family life of miners, and delayed coal mining and production. This time, we take the most serious and most representative accident for analysis - 3047 (1) working face "11.3" rock burst accident.

On November 3, a ground pressure accident occurred in the flat lane under the 3407 (upper layer) working face, which belongs to a relatively large accident level, resulting in property losses of tens of millions of yuan , a large number of machines damaged, malfunctioning, and broken. One person died and many were injured.

At 22:30 on the evening of November 3, the working face exploded for the first time. Half an hour later, the construction workers entered the working face to work again. At this time, the working face was already in an unstable state, but the construction staff did not have any vigilance and continued to carry out the operation construction. Until 23:22, the construction personnel found that there was thunder in the depths of the coal body of the working face. At this time, the deep part had been impacted. The staff missed the best escape time. 13 construction workers and 13 workers in Xiaping Lane were also injured to varying degrees.

In addition, the impact also caused the bottom end of the pillar 50m in the lower part of the working face to move to the old air side, and more than 50 pillars within 10m below were almost all damaged, and the bottom drum was 0.4-1.2m. The length of the 40m roadway section outside the roadway was shortened to 1/5 of the original length due to the impact, which caused partial blockage in the roadway, and the shrinkage rate of the end face also exceeded 50%. The impact force generated by the impact accident can even eject a 40-ton object beyond 1m.

3.2. Risk analysis of coal mine rock burst disaster based on fishbone diagram

3.2.1. Environmental factors

The coal seam has a tendency to impact. Huafeng Coal Mine is mainly composed of 4 layers of coal, and the roof coal seam is laterite layer, so the stability and compression resistance are extremely poor. The integrity of the middle two layers of coal is in the middle, and the bottom coal seam is a conglomerate layer, which has good ductility and strong compression resistance. When the working face is subjected to concentrated stress, the roof coal seam has a strong tendency to impact, resulting in the continuous collapse and fracture of the central coal seam, forming a cavity, which is also the main reason for the impact accident in the mine.

Conglomerate activity leads to impact force. With the continuous advancement of the mining working face, the upper sandstone layer regularly collapses and faults appear, and the overlying laterite layer also breaks with the collapse of the sandstone layer; while the boulder layer on the floor has strong compressive resistance, strong tensile ability , good ductility, strong integrity, not easy to deform, therefore, this mining area and laterite layer will form a hollow space, and with the progress of the excavation work, the hollow area gradually increases. At this time, the original stress state of the 70-meter-thick conglomerate layer and laterite layer has changed, and the stress level of the entire goaf face is unbalanced, which leads to an increase in the stress level of the working face. When the exposed area and stress level of the upper soil layer reach a certain level, an accident occurs.

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Rock fracture aggravates the occurrence of rock burst. The surface layer of the working face mined in Huafeng Coal Mine is mainly a hard conglomerate layer, and the soil layer has strong integrity, strong compressive resistance and strong compressive resistance. The rock mass is subjected to severe impact load, and when the bearing force reaches the limit, the impact of the rock mass occurs.

3.2.2. Personnel factors

Insufficient safety knowledge and technical reserves create hidden dangers for accidents. First of all, working in a dangerous industry should have corresponding safety knowledge and safety technology, and only after formal safety training can be employed to ensure that staff have basic safety awareness. In this impact accident, when the working face is advancing, with the increase of the goaf, the upper rock will be separated from the layer, thus forming a transfer stress structure, resulting in high stress concentration, because Li and the other 13 workers did not With the corresponding rock mass mechanics theory, no new support is added when the stress such as simply supported beam and cantilever beam reaches the limit, which causes the support of the working face to be unstable and increases the probability of impact accidents.

Accidents are induced by the staff firing guns on the mining face. Rock activity itself has energy, and with the continuous excavation of the working face, the energy released by the rock continues to increase. If the working face is fired at this time, it is easy to release the energy of the rock mass, which will cause collision between the rock masses and shock. Huafeng Coal Mine did not take into account the geological structure of the coal seam during mining, and rashly fired guns to release a large amount of rock mass energy in a short period of time, which was one of the main reasons for inducing coal mining face impact accidents.

3.2.3. Equipment factors

The support equipment is not in place. Supporting equipment is the key to the entire infrastructure and the key to ensuring the safety of construction workers. The supporting equipment used in Huafeng Coal Mine is a metallic front-beam, which has weak compression resistance and poor ductility. The construction unit did not select and inspect the quality of the support as required, and cut corners during construction, which reduced the stability of the roadway support and increased the risk of collapse, which led to the occurrence of rock bursts.

The security monitoring system is backward. The sensors used in the working face of Huafeng Coal Mine are susceptible to interference. Due to the interference of impurity gas and the instability of the electrochemical sensor itself in the underground environment, false alarms or no alarms are often reported. When the working face has a tendency of shock accidents, the sensors of the 3407 working face do not sense the dangerous underground environment or feel it and do not alarm. The staff did not detect the danger, which led to the Huafeng Coal Mine mining under unsafe conditions, and eventually the accident occurred.

3.2.4. Process factors

The mining layout is risky. (1)Pillar Risk. When the working face is subjected to concentrated stress, the coal volume accumulates a large amount of elastic energy, and with the increasing degree of stress concentration, rock burst accidents are prone to occur. Huafeng Coal Mine is a thick coal seam. Under the action of high stress on the working face, coal pillar-type rock bursts are formed. (2)Bottom coal retention risk. The strength and load level of the coal seam floor are the main factors that determine the rockburst of the floor. In the working roadway of Huafeng Coal Mine, the roof and roadway are generally supported, but the bottom plate is generally not supported, which makes the weak bottom plate first affected when the working face is subjected to concentrated load.

Working face mining disturbance. All the activities of the working face will affect the surrounding rock of the roadway, and the main affecting activities are mining activities. According to relevant regulations, when the distance between the excavation working faces is less than 150m, the distance between the excavation working faces is less than 50m, and the distance between the coal mining working faces is less than 500m, the excavation disturbance frequency is high and the impact is obvious. However, most of the roadways of Huafeng Coal Mine do not meet these regulations. Therefore, with the increase of the excavation depth, the probability of rock burst accidents also increases greatly.

Impact of roadway expansion and repair. There are a lot of expansion projects in Huafeng Coal Mine. The expansion projects will change the original stress field distribution of the roadway, and the microseismic activity will increase significantly, resulting in bending, deformation and fracture of the

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coal seam, and there is a high probability of rock burst accidents.

3.2.5. Management factors

The coordination mechanism is not perfect. At present, the policies used by Huafeng Coal Mine are cumbersome and complex, and they have not been sorted out and adjusted, which increases the possibility of conflict between policies.

The supporting rules and regulations are not perfect. The long-standing policy of Huafeng Coal Mine has certain flaws, especially the personnel policy is inconsistent with the practice, many of the staff have not undergone strict assessment when hiring, and do not have the corresponding ability to be competent for the job. The content of the assessment is also a mere formality, with no substantive content. In the accident, Mr. Li and his staff did not meet the requirements of the enterprise, and were not able to deal with the problems in the working face in time because of their lack of ability, laying a hidden danger for the occurrence of the impact accident.

The emergency plan formulated is not scientific. There are many uncertain factors in the mine, any small loophole in the construction may cause a particularly serious accident, especially the Huafeng Coal Mine has thick coal seam, complex structure, large mine, many construction workers, and many emergencies. The plan lacks scientificity and feasibility, and is not enough to deal with all possible accidents. Therefore, continuous improvement and rectification are required.

Incomplete observation and analysis of rock pressure. The terrain of the mine is uneven, and the pressure varies from place to place. The geological structure of Huafeng Coal Mine is complex and requires careful investigation. However, the miners only estimate the approximate pressure value during the mine construction, so the observation and analysis based on these data are not enough. Accurate, which leads to deviations in the selection of support equipment and forms later, resulting in unstable mining face and impact accidents.

Regulatory authorities are not in place. The supervision of the Huafeng Coal Mine supervision department is not strong enough, there is a gap with the requirements, the law enforcement is loose and soft, the real problems cannot be found, the hidden dangers are not rectified, the risks are not controlled and controlled, and the risk rectification and control investigation is a mere formality, resulting in the failure to detect and correct potential impact hazards. In fact, this is also an important reason for the ubiquity of most coal mines.

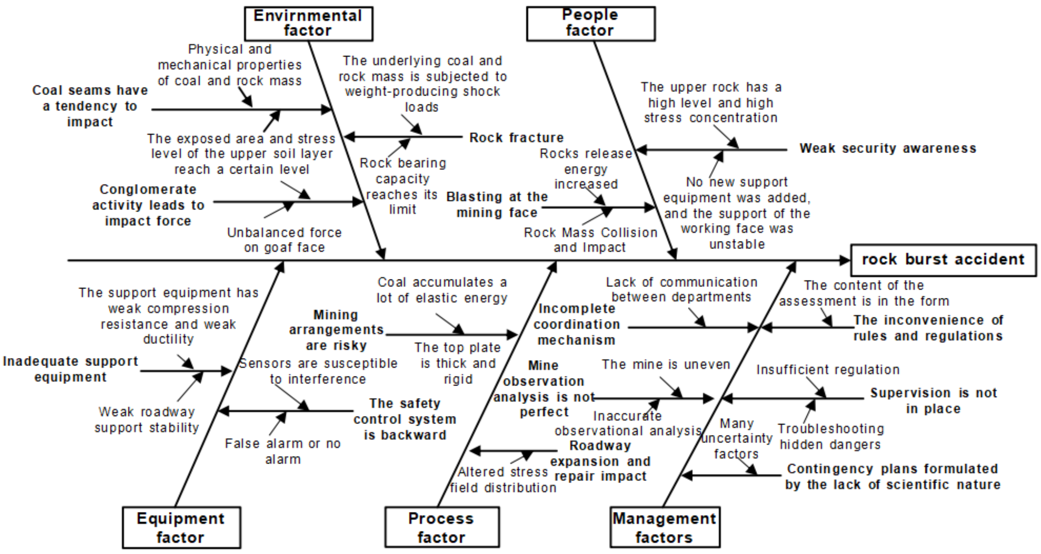

Figure 3: Fishbone diagram model of coal mine rock burst disaster

3.3. Risk analysis of coal mine rock burst disaster based on STAMP /STPA model

3.3.1. Identify systemic risks

System-level accidents in coal mine rock burst accidents mainly include casualties and roadway damage. In the coal mining face, due to the complex structure of the mine and the influence of some geological conditions, there may be errors in control behavior, judgment errors, inaccurate information

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transmission, and misoperations caused by external factors. On the way of support, etc; there is a greater risk caused by adverse factors. The No. 3 liaison road where the accident occurred and the coal rock seam of the 1303 working face are also relatively complex. The combination of various chaotic factors eventually led to the outbreak of the accident. The fundamental reason is that the coal seam floor has a tendency to impact, which will cause the rock burst accident produce.

The primary reason is that under the action of the impact tendency of the coal seam and its roof and floor, the stress and energy of the coal seam undergo great changes. The secondary reason is that the coal seam reaches the limit deformation, the natural water content is low, and the thickness changes greatly.

The second is that under the combined action of the two, it is mainly manifested as high stress concentration, stress mutation and high energy storage. The stress concentration is mainly caused by the large coal mining depth, the large mining area and the lack of pressure relief measures. The sudden change of stress is mainly caused by the fracture and displacement of the roof thick rock during the mining activities, and the roof collapses.

Finally, under the action of the above physical forces, a high degree of energy is stored in the roadway working face, and after reaching a certain amount, the impact collapse occurs, resulting in the accident mentioned above. The development of joints in the coal seam, the gangway caused by the umbrella eaves, and the sudden encounter with the geological structure constitute the indirect cause of the accident through analysis.

3.3.2. Clarify the safety constraints of rock burst accidents

Scientific construction plan and rock burst prevention system. In roadway excavation, it is necessary to strictly follow the prescribed plan, strictly prohibit all unsafe actions, promptly remove the unsafe state of objects, strengthen supervision and monitoring, and preferably achieve advance prediction and prevention. However, due to the complexity of the coal seam and rock mass, accidents may occur during the specific construction process, which requires the formulation of emergency plans and emergency measures.

Determine whether the coal rock mass has impact tendency. The so-called shock tendency refers to the natural property of whether the coal rock mass may burst into rock burst, and this property can be judged by laboratory tests. Whether the coal rock mass has the tendency to shock is one of the very key evidences for evaluating whether the coal mine has the risk of rock burst explosion.

Exploration of geological conditions. Accurately determine the geological structure and rock formation trend, as well as the coal seam and roof conditions.

Support. As a kind of isolation of danger sources, support plays an important role: firstly, it can ensure the safety and stability of the surrounding rock mass of the roadway; secondly, it can ensure that the surrounding rock mass of the roadway does not collapse; thirdly, it is the ultimate protection Safety of people and things.

3.3.3. Building a multi-level structure control model

In this rockburst accident, the needs and constraints of different management layers seem to be independent, but they are actually closely linked. In view of this accident, the biggest problem is that the constraints between the various managements are not well managed and communicated with each other, and the respective managements have been separated from the overall construction, so that their respective demand constraints have become scattered, resulting in Accidents happen, and an accurate emergency plan cannot be made.

The production environment in which each management is located is different, and the disposal measures and management mechanisms they face are the same. In this accident, since the three managements could only see their working environment one-sidedly, although they made a decision on the protective measures for stamping, due to lack of communication and feedback to the superior, this made the No accident occurred, but when high energy and high pressure accumulated, the correct disposal plan made by the previous level could not be obtained, and finally the construction could only be continued when it settled on the construction layer. When an accident occurred, the construction layer did not take emergency measures as a result of that they couldnot escape the damage of the shock.

Therefore, in the STAMP model, each subsystem or component in the multi-level control structure to prevent rock burst accidents is implementing safety constraints and controls, but to understand the cause of the accident and analyze the accident in depth, it is also necessary to Put each component into

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a specific situation to analyze, because each layer of the control structure is different, so as to find out which layer of safety constraints has a problem when an accident occurs. First, analyze the location and basic conditions at the time of the rock burst accident, and consider at the level that interacts with it, analyze the control structure and control behavior of each layer in turn, and analyze the control defect factors, from people, objects, environment and Find the real reason by digging through the factors of management. Here, a hierarchical safety control structure analysis is carried out for the rockburst accident, as shown in Figure 4.

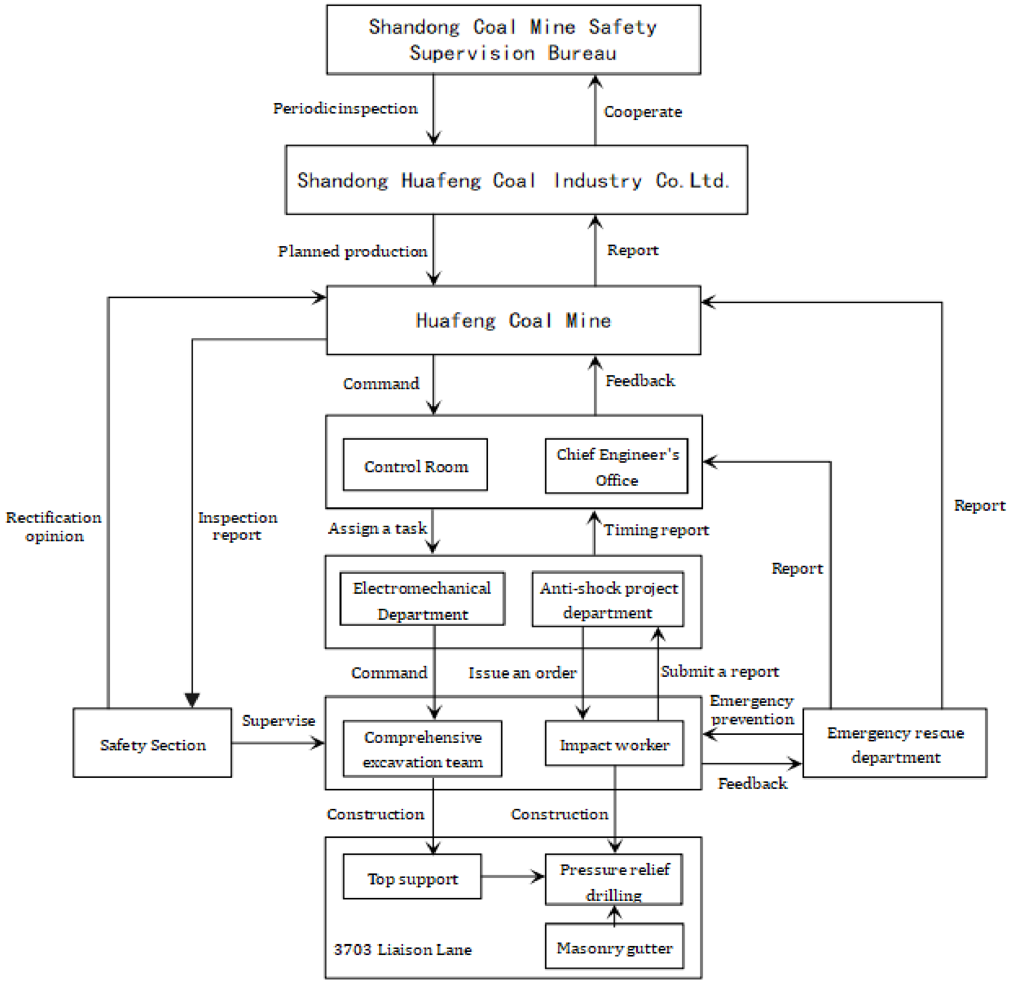

Figure 4: The rock burst disaster control model based on STAMP /STPA model

4. Research on the risk prevention and control system of major disasters caused by rock burst in coal mines

4.1. Establish a set of safety prediction and early warning mechanism for major disasters in coal mines

Establish a complete rockburst monitoring system. Continuously innovate the technologies and means used in monitoring, and make sure to do a good job of forecasting. For some mines prone to rock bursts, a risk analysis and evaluation system and forecasting function must be established. The chief engineer shall review and put forward reasonable opinions on the prediction and forecast results of the impact risk degree of each mining face, and establish corresponding archives for backup.

In the mining area with high risk of rock burst, it is necessary to understand some ground pressure data, such as: the elasticity and brittleness of the coal seam in the properties of the coal seam; the water content of the coal seam; the avoidance of folds and fault areas in the geological structure; the thickness and strength of the roof and floor of the coal seam.

4.2. Construct a set of coal mine safety training and education system for major disasters

Strengthen communication between organizations. The mine manager and legal representative are the first responsible for the prevention and control of rockburst, and the chief engineer and technical leader conduct technical prevention and control of rockburst accidents. Through research and analysis, it is found that communication between organizations at all levels of the system is an important measure to reduce inappropriate decisions and behaviors. Therefore, strengthening communication between organizations and ensuring effective communication between all levels in the entire system can reduce accidents occur.

Rockburst mines must regularly educate and train relevant operators on rockburst prevention and control according to the rockburst prevention and control training system, to ensure that the personnel who go down the mine have sufficient knowledge and skills of rockburst prevention. Through the analysis of control actions and STAMP model, it can be seen that the occurrence of major rock burst accidents in Huafeng Coal Mine is due to the wrong behavior of inadequate safety training among organizations, and the safety knowledge and safety awareness of employees are not perfect. Therefore, it is necessary to strengthen safety training, carry out emergency drills on a regular basis, and regulate the behavior of employees through a reasonable reward and punishment system to reduce the occurrence of accidents from the root cause.

5. Conclusion

The coal mine rock burst accident has now become one of the major production accidents in my country. Due to the complex causes of the accident, it is difficult for the traditional accident analysis model to analyze the accident comprehensively. Based on the fishbone diagram and the STAMP /STPA model, the system adopts the system safety evaluation method, and through the construction of the model and feedback, the risk factors in the system can be accurately identified and effective control methods can be found, so as to prevent the occurrence of such accidents. Therefore, this paper uses the fishbone diagram and STAMP /STPA model to analyze the major rock burst accident in Huafeng Coal Mine, aiming to find out the cause of the accident and analyze it, absorb the accident experience, and improve the safety of production operations.

(1)According to the fishbone diagram and the STAMP/STPA model, from the perspective of system cybernetics, the causative analysis of the rock burst accident is made, and it is found that there are many factors that cause the accident, but they are generally divided into interference, management defects, constraint feedback failure, etc. Among them, it mainly analyzes the failure behavior of constraint feedback at all levels, such as the ineffective supervision of the superior department, the inappropriate issuance of orders, the untimely feedback and the wrong implementation of the subordinate department, and also various external disturbances. Ground pressure conditions are ripe, resulting in accident losses. Therefore, in daily production operations, each department must perform its own duties and fulfill their responsibilities to ensure that constraints are implemented in a timely and accurate manner, and pay attention to monitoring and timely feedback and exchanges to minimize sources of danger.

(2) Using the fishbone diagram and STAMP /STPA model to analyze the coal mine rock burst accident, obtained the physical process and various reasons of the management, and also found out the mutual influence between the different constraints that control the rock burst accident reason. The impact tendency of the coal seam itself and the excessive depth of the mining depth are the main factors of the accident.

(3) Although the technical defects of coal miners are not the direct cause of the accident, due to insufficient safety education and training for employees by the relevant departments of the company, weak awareness of rushing, inaccurate prediction of danger, and supervision by local regulatory authorities Failure is also the main cause of accidents.

Of course, there are still some flaws in the mine safety evaluation of the squadron in this paper. It only studies the impact of the impact factors on mine safety, and does not fully understand the impact of various aspects on mine safety. In order to ensure mine safety as much as possible the evaluation of mine is more accurate. We should analyze various influencing factors, not only the impact of a single rockburst on the mine, but also include more aspects, so as to carry out the most accurate risk management and control of the safety of a mine.

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References

[1] Cook N G W, Hoek E P, Pretorius J P G, et al. Rock mechanics applied to the study of rockbursts[J]. Journal- South African Institute of Mining and Metallurgy. 1966, 66(10): 435-528.
[2] Cook N G W. The failure of rock [J]. International Journal of Rock Mechanics & Mining Sciences & Geomechanics Abstracts. 1965, 2(4): 389-403.
[3] Bieniawski Z T. Mechanism of brittle rock fracture. Part II. Experimental studies [J]. International Journal of Rock Mechanics & Mining ences, 1967, 4(4):407-423. [J].
[4] Singh S P. Burst energy release index [J]. Rock Mechanics & Rock Engineering. 1988, 21(2): 149-155.
[5] Kidybiński A. Bursting liability indices of coal [J]. international journal of rock mechanics\&\mining sciences\&\geomechanics abstracts. 1981, 18(4): 295-304.
[6] Zhang Guangchao, Li You, Meng Xiangjun, Tao Guangzhe, Wang Lei, Guo Hanqing, Zhu Chuanqi, Zuo Hao, Qu Zhi. Distribution Law of In Situ Stress and Its Engineering Application in Rock Burst Control in Juye Mining Area [J]. Energies, 2022, 15(4).
[7] Lin Manqing, Gao Chengcheng, Xia Yuanyou, Zhang Dianji, Liu Xiqi, Liang Xiaoshuai. Rock burst initiation and precursors in a model specimen based on acoustic emission and infrared monitoring [J]. Arabian Journal of Geosciences, 2022, 15(4).
[8] Li Dejian, Li Chunxiao, Liu Xiaolin, Qi Hao, Shao Yiming. Error calibration for kinetic energy of rock burst ejected fragments based on the binocular high-speed photography system [J]. Arabian Journal of Geosciences, 2022, 15(2).
[9] Cao Anye, Liu Yaoqi, Jiang Siqi, Hao Qi, Peng Yujie, Bai Xianxi, Yang Xu. Numerical Investigation on Influence of Two Combined Faults and Its Structure Features on Rock Burst Mechanism [J]. Minerals, 2021, 11(12).
[10] Ma Zhiyong, Feng Wenkai, Wang Zhen, Lin Fujin, Li Dayong, Feng Gan. Study on the Formation Mechanism of Rock Burst Caused by Seam Floor Slip under an Ultrathick Conglomerate [J]. Mathematical Problems in Engineering, 2021, 2021.
[11] Xu Pengbo, Shao Junjie, Fan Dong, Chang Jianghua, Zhang Ning. Analysis of pressure relief effect of borehole in rock burst mine [J]. Energy Reports, 2022, 8(S2).
[12] Zheng Chunmei, Zheng Jiayan, Peng Xiaojuan, Zhou Lei, Zhang Xuepeng. Study on Failure Characteristics and Rock Burst Mechanism of Roadway Roof under Cyclic Dynamic Load [J]. Shock and Vibration, 2021.