

Study on Evaluation Index System of Green mine construction

Li xin^{1,a}, Yang JunJie^{1,b}, Yan Hongcai^{2,c} and Cao Hongjun^{3,d}

¹School of Environmental Science and Engineering, Ocean University of China, Qingdao, China

²School of Management, Ocean University of China, Qingdao, China

³Corresponding author, School of Environmental Science and Engineering and School of Management, Ocean University of China, Qingdao, China

E-mail: ^alixin_zhaozhao@126.com, ^bjjyang@ouc.edu.cn,
^c15683409107@163.com, ^dhongjunsd@163.com

Abstract. Green mine is a new and science comprehensive construction mode of mine, which runs the concept of green development through the whole process of mineral resources development and utilization, promotes the transformation and upgrading of mineral enterprises and achieves the healthy and sustainable development of mining industry. This paper is based on "the basic conditions of national green mine", combined with the current situation of green mine construction, constructing green mine construction evaluation index system which is divided into five areas, including management, comprehensive utilization of mineral resources, technological innovation, ecological environment and cultural construction.

1. Introduction

Green mine is a new and science comprehensive construction mode of mine, which achieving scientific mining, resource conservation and intensive utilization, the standardized management of enterprises, environmental protection of the production process, and ecology of closed pit mine by changing the traditional mining mode of mine construction, in order to realize the harmonization among mine resources development and utilization, economic and social development and ecological environment protection.

The green mine construction is the specific embodiment of the construction of ecological civilization and inevitable requirement of promoting the formation of the new development concept of green development and lifestyle. It further implements Scientific Outlook on Development, based on our national conditions, following the development principles of the green economy, circular economy and low-carbon economy, developing green mining, constructing the long-term mechanism of regulating development and utilization of mineral resources, greatest increasing rate of resources, reducing the waste of resources, alleviating the pressure on the environment, promoting the change of development methods of mining from extensive to intensive. At the same time, the green mine runs the concept of green development through the whole process of mineral resources development and utilization, which promotes the transformation of mining production methods, ensures the healthy development of the mining industry and further promotes the sustainable development of the economy and society. On the basis of summarizing and analyzing the development status and restricting factors of green mine, this paper which follows the basic principles of constructing evaluation index system of green mine construction builds green mine construction evaluation index system and can provide the reference for the design of green mine construction mode.



2. The Present Situation and Restriction Factors of Green Mine Construction

Since the concept of green mines was put forward, "national mineral resources planning (2008-2015) (hereinafter referred to as "planning") was published and "China Mining Association Green Mining Convention" was adopted in 2009 and "the Guiding opinions on carrying out national mineral resources planning, developing green mining industry and building green mines from the Ministry of land and resources" (hereinafter referred to as "opinions") was published in 2010, the green mine is not only known by the mining fields or cognized by enterprise and institution as an idea, but also is known as the fundamental way to solve the mine transformation and upgrading and promote sustainable development of Mines.

Since the "opinions" was published, the Ministry of land and resources of PRC announced 661 state-level green mine pilot units in four lots in 2011, 2012, 2013 and 2014, which involves several mineral Ores including petroleum, natural gas, coal, nonferrous metals, gold, chemicals and so on. Up to now, the green mine construction of China has succeeded initially. But considering the fact that there are many mines in China, the number and the scale of green mines construction are small significantly, the construction speed of green mines has not reached the level of overall construction and overall promotion, and at the same time, there are many restricting factors that influence the development of green mines.

First of all, the state has not formulated a sound supporting policy for the green mines construction, in the results, the green mining enterprises has not obtained the superiority than the non green mining enterprise. Furthermore, in the management process, the country takes the measures of restriction and punishment to green mines, which, to some extent, has suppressed the enthusiasm of mining enterprises to build green mines.

Secondly, as a big country of mineral resources, during the process of exploitation and utilization of mineral resources, China is also faced with the problem of resource depletion and searching for replacement resources. Recently, in order to change the dominant position of mining industry, government departments promote scientific and technological innovation greatly by various preferential policies and encourage the development of new energy sources.

Thirdly, the number of Chinese mining industry is large, but the scale is small, the mineral resources are exhausted day by day and the degree of difficulty of mining is bigger and bigger, and then some small and medium-sized enterprises are facing a severe shortage of funds, which can not invest a lot of money and manpower to build green mines and realize the transformation and upgrading of mining. So, the development of green mines construction is restricted greatly.

Fourth, The China Mining Federation issued "national green mine pilot unit acceptance evaluation index and scoring table" which delineated 10 categories of evaluation indicators in 2004. The evaluation indicators total 35 items, but only 6 indexes including mining recovery rate, ore dressing recovery rate, coal preparation quantity efficiency, scientific and technological innovation input ratio, energy consumption index and reuse rate of ore dressing wastewater have given the minimum quantification standard. Green mine construction is a complex and huge comprehensive system, so the relatively general evaluation standards can not reflect the construction level of green mines and we can not know the development level of green mines construction. Therefore, in order to realize the healthy and sustainable development of China's mining enterprises correctly, establishing the perfect evaluation index system of national green mine construction has become the first problem to be solved for the construction of green mines.

3. Constructing the Evaluation Index System of Green Mines Construction

3.1 Principles of constructing the evaluation index system of green mines construction

On the basis of green economy, circular economy and low carbon economy for development, the design of index system of green mines construction which adheres to the principle of unifying the exploitation and utilization of mineral resources, the development of economy and society and the protection of ecological environment should evaluate the construction level of green mines objectively,

scientifically and comprehensively. The evaluation standard system of green mines construction should be guided by the following three principles:

Combining science and objectivity. Based on relevant scientific theories, the design of evaluation index system of green mines construction must pay attention to the coordination of many factors in the process of mining development and other factors including resources, economy, society, ecology, environment and so on. As the basis of measurement and evaluation, the index system must reflect the present situation of green mines construction and development objectively and truly, and meet the basic requirements of the sustainable development of green mines.

Combining goal and dynamics. The purpose of establishing the evaluation index system of green mine construction which is a dynamic development process is to guide mine enterprises to carry out scientific transformation and realize the sustainable development of mineral resources and urban social economic and ecological environment. Therefore, the establishment of the evaluation index system should be based on sustainable development, take full account of the characteristics of the dynamic changes of green mine construction, and show the development trend of the system.

Combining typical comparability and operability. The evaluation index system of green mine construction whose subsystems are independent and interact with each other is a rather complicated system. So, typical indicators should be selected to reflect whether the green mine construction is qualified correctly. All data relating to the indicators can be obtained from the current national system or hard transaction. Furthermore, in order to avoid the design of the index system is too cumbersome, it is necessary to reduce the number of qualitative or quantitative indicators as much as possible to make the use of the index system more operational.

3.2 Research methods of constructing evaluation index system of green mines construction

There are many methods to construct the evaluation index system. This article mainly adopts the following methods:

Evaluation level set method. Because it is difficult to use the specific scores to express the evaluation results of each evaluation index of green mine construction, the evaluation results can be divided into five levels including excellent, good, qualified, poor, very poor and so on by the evaluation level set method.

Principal component extraction method. Because the relationship among the subsystems of the evaluation index system of green mine construction is complicated, it is difficult to judge the construction level of green mines intuitively from each index. The principal component extraction method is used to determine the index weight from the objective and scientific point of view. In other words, a few simplified synthetic indexes which are extracted from all indexes are used to construct a comprehensive evaluation model of green mine construction level.

Fuzzy analysis method. First of all, the hierarchy of the evaluation index system of green mine construction need to be established, and then be compared and analyzed between each other. At the same time, all the index values should be blurred in the evaluation grade. Finally, the fuzzy index value is summed up to the corresponding grade for evaluation.

3.3 Constructing evaluation index system

In order to regulate mining behavior and promote the development of green mining industry, in particular, the state has formulated "basic conditions of national green mines" (hereinafter referred to as "basic conditions") which is consistent with the basic requirements of sustainable development and transformation and upgrading. Therefore, construction of green mine construction evaluation index system must satisfy "basic condition". Because only these mining enterprises which satisfy "basic condition" are eligible to participate. Similarly, the green mine construction evaluation index system should also meet the requirements of the "basic conditions". Based on the "basic condition", taken the "opinions" as the guide and combined with the present situation of green mine construction, this paper summarizes nine third-level indicators and five secondary indicators including the management, comprehensive utilization of mineral resources, scientific and technological innovation, ecological

environment and cultural construction. (the specific details are shown in Figure 1).Furthermore,according to the fundamental principle of constructing green mine evaluation index system,applying relevant development strategy analysis tools,using three research methods including evaluation level set method,principal component extraction method and fuzzy analysis method,a set of green mine construction evaluation index system is constructed.(the specific index system is shown in Table 1).

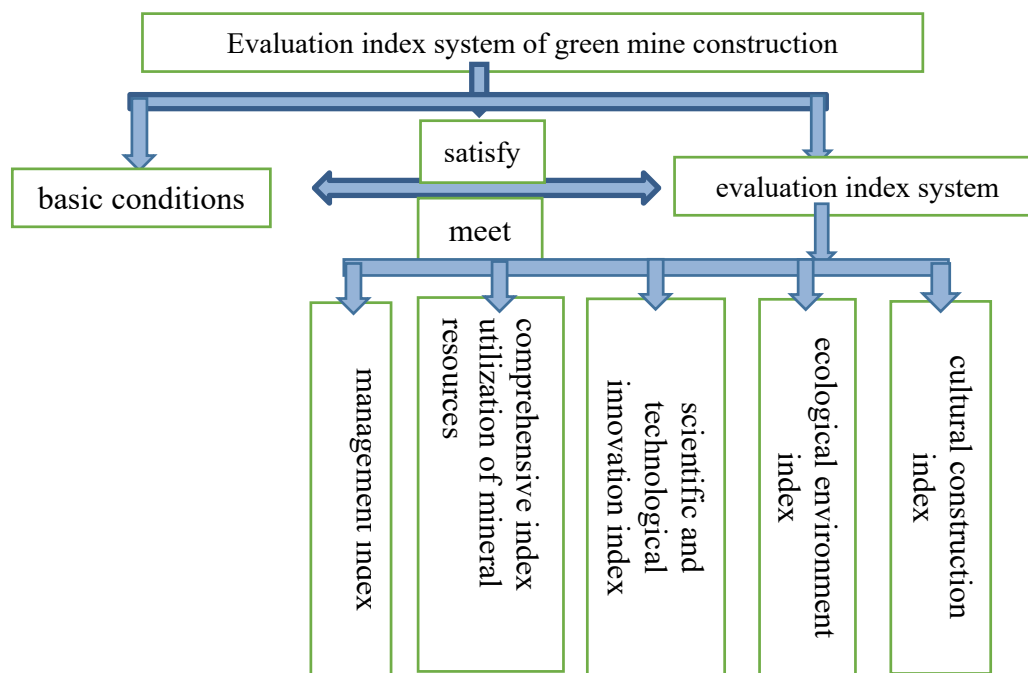


Figure 1 structure diagram of evaluation index system of green mine construction

Table 1 evaluation index system of green mine construction

Primary index	secondary index	third-level index	four-level index
evaluation index system of green mine construction	management index	management index of mine specification	number of legal documents;perfectness of management systems and regulations;implementation of supervision and audit mechanism;completeness of archival sources;rationality of production level of each link;cleanliness of mineral appearance;mining supervision.
		management index of safety	perfectness of safety management system, management organization,management system and safety operation procedures;construction conditions of emergency rescue mechanism;maintenance prevention;continuous safe production time; safety education of workers;technical training for workers' safety in production.
	comprehensive utilization index of mineral resources	mineral production index	scientific rationality of development plan;compliance rate of "three rate"(recovery rate,mining dilution rate,recovery rate of mineral separation);recovery rate of waste resources;utilization rate of tailing;comprehensive utilization rate of mineral resources;comprehensive utilization rate of associated mineral resources.
		energy consumption index	energy consumption per unit yield;water consumption per unit yield;non renewable resources consumption per unit yield; labour productivity rate of all-personnel;the rate of green energy accounting for total energy.
	scientific and technological innovation index	management innovation index	the rate of scientific and technological innovation investment accounting for total investment of mine construction;management rules and regulations innovation level;quantity of scientific research reports which have been reviewed already;the rate of technical staff.
		technical innovation index	scientific and technological level of mining(mine,separate ore,smelt) ;dust-free production process;progressiveness of piercing and makeup equipment;progressiveness of crushing and transporting equipment;green technology proportion;high-tech proportion.
	ecological environment index	environmental protection index	the plan of mine environment protection and comprehensive treatment;implementation of environmental protection measures;implementation of "three at the same time" system;discharge of "the three wastes";noise pollution level;vibration pollution level;processing rate of "the three wastes";total emission reduction rate of major pollutants.
		ecological restoration index	the plan mine treatment recovery;mine closed pit planning and utilization and monitoring of subsequent land;compliance rate of air quality ;compliance rate of water quality;the rate of land reclamation;the rate of forest coverage;the rate of ecological environment restoration.
	cultural construction index	enterprise culture construction index	Integrity of negotiation mechanism;construction of enterprise ecological civilization;staff consciousness training of green environmental protection.

4. Conclusion

Based on fully understanding the premise of green mine construction, following the green development concept, implementing scientific development concept, being realistic and guided by the healthy and sustainable development of mining industry, this paper constructs the evaluation index system of green mine construction which provides the basic reference value for the design of green mine construction mode and a reference scheme for designing green mine construction models and policy recommendations for relevant areas and management departments. But the index weight ratio and index setting of the index system established in this paper need further research and exaltation. It is

believed that the evaluation index system of green mine construction will be more perfect with the continuous development of green mine construction.

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References

- [1] Yang Junpeng, Dai Huayang, Zhang Jianwei, China's green mine construction problems and solutions under new normal conditions, China mining, 2017.01
- [2] Peng Jianping, Shen Shubao, long term mechanism and typical cases of green mine construction, Gold science and technology, 2016.08
- [3] Song Xuefeng, Wen Bin, quantitative evaluation research on green mine construction level. China mining, 2014.04
- [4] Lai Xiaoying, research on evaluation indexes and methods of green mine construction, Resource saving and environmental protection, 2013.08
- [5] Yan, Zhigang, Liu Yupeng, Wang Xueli, research on evaluation indexes and methods of green mine construction, China coal, 2012.02.5
- [6] Zhang Deming, Jia Xiaoqing, Qiao Fansheng, Li Xin, Zhao Shiliang, Hu Ke, preliminary study of green mine evaluation index system, Renewable resources and recycling economy, 2010.03
- [7] Huang Jingjun, Ni Jiazeng, Song Yunfei, Wang Yujun, Zhu Gu, the study on evaluation index system of green mine construction, Metal mine, 2009.11