

Industry innovation, corporate social responsibility, and risk management of coal enterprises in Shanxi Province: Basis for an environmental management performance framework

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Abstract

This study examines the industrial innovation, CSR, and risk management of coal enterprises in Shanxi Province. The aim is to assess the status of these companies in terms of industrial innovation, CSR implementation, and enterprise risk management capabilities, particularly focusing on their comprehensive green innovation capabilities, stakeholder engagement, and identification, assessment, handling, communication, and reporting of corporate risks. Additionally, it aims to outline the specific content of industrial innovation in coal enterprises and analyze the relationship between these initiatives and corporate social responsibility and risk management. Finally, the study focuses on the framework of environmental management performance in coal enterprises. The insight from this study is that if a coal company has high levels of industrial innovation capability, then its green innovation capability, green innovative technology, and green organizational identity are intrinsically linked in multiple aspects. Improving the environmental management performance of such companies depends on two aspects: one is the company's comprehensive industrial innovation capability, and the other is its performance in fulfilling corporate social responsibility and risk management capabilities. Findings outline several key pathways for coal companies to enhance environmental management performance. Companies urgently need to implement green-driven strategies, with setting up dedicated innovation funds being a crucial approach to achieving this goal. They must also more actively fulfill their corporate social responsibilities, establish continuous improvement mechanisms for environmental management, boost risk management capabilities, and build information sharing platforms, all of which are vital for sustainable development. Embracing green innovation technologies to elevate industry innovation levels is equally important as strengthening internal controls and strategic assessments within the company. Finally, this study develops a comprehensive environmental management performance framework for coal companies.

Keywords: industry innovation, corporate social responsibility, risk management, environmental management performance framework

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1. Introduction

Under the dual pressures of global energy transition and environmental protection, the coal industry, a crucial part of traditional energy, is facing unprecedented changes and challenges. The coal industry is not only a pillar of local economies but also a vital component of the national energy strategy. As the world's largest producer and consumer of coal, China's coal enterprises face significant challenges in their sustainable development. The production and operation of the coal industry have a substantial impact on the environment. The Chinese government places a high priority on the green transformation and development of the coal industry, implementing a series of policies and measures. It also encourages and supports coal enterprises to engage in green innovation, promoting the industry's green and low-carbon development and enhancing environmental management capabilities.

Shanxi Province is a great province for coal reserves and development, situated in northern China. Shanxi's coal enterprises have developed a comprehensive industrial system (Hong et al., 2023). These companies have not only led the duty to ensure the national energy security and local economic development but also take on the historical responsibility to promote green and low carbon progress so as to bring win-win situation to development and environment respectively.

During its development, Shanxi province has been actively in response to the call from the nation, continually enhancing environmental management performance of coal enterprises with technological innovation, industrial renovation and management innovation. On the other hand, over a long period, environmental pollution, resource consumption, and safety risks in the coal production and processing processes have already become major bottlenecks restricting the sustainable development of the coal mining industry (Wang et al., 2022). Shanxi's coal enterprise green innovation and social responsibility and risk control is still short of perfection. How could such businesses make improvements in its environmental management through green innovations, improving the sense of corporate social responsibility, and managing risks, is a topic that academic and practical people both take a look into. Therefore, through in-depth research on the above problems, this study hopes to propose some specific solutions to provide theoretical evidence and reference for promoting the environmental management performance of Shanxi coal enterprises more comprehensively (Guo et al., 2022). The innovation of the coal industry, corporate social responsibility, and risk management in Shanxi Province are key concerns for both academic and practical circles. However, there are still many research gaps and shortcomings, particularly in studies addressing the specific context of Shanxi's coal enterprises, which makes it challenging to provide targeted guidance for their transformation and upgrading. Therefore, this study aims to propose practical and actionable recommendations by considering the actual conditions of Shanxi's coal enterprises and market demands.

This research focuses on three critical areas for coal enterprises in Shanxi Province, China: industry innovation, corporate social responsibility (CSR), and risk management. Through in-depth study and analysis of these enterprises, the researcher will uncover specific measures, achievements, and challenges related to industry innovation. The researcher will also analyze their performance in corporate social responsibility and evaluated their risk management strategies, capabilities, and existing problems. Ultimately, this research seeks to provide theoretical assistance and practical guidance for the sustainable growth, industrial transformation, and enhance environmental management effectiveness of coal companies in Shanxi Province and beyond.

Objectives of the Study - This study was conducted to assess the industry innovation, corporate social

responsibility and risk management of coal enterprises in Shanxi Province, China. Specifically, it assessed the industry innovation of green innovation ability, green innovation technology and green organization identity; evaluated CSR by environment, social and economics; described risk management by risk identification and assessment, risk treatment, risk communication and reporting; tested significant relationships among industry innovation, CSR and risk management; and developed a performance framework of enterprise environmental management of coal enterprises in Shanxi Province, China.

2. Methods

Research Design - The researcher used a descriptive research design to have a proper and correct interpretation of the results. This method was used for any studies that were trying to present facts about the nature and status of something, meaning even a survey study and a correlative study. According to Hosseini et al. (2021), descriptive research as a research method used to describe the existing phenomena as accurately as possible. The term "existing phenomena" makes descriptive research the opposite of experimental research, observing both existing phenomena and observed phenomena after a period of time. What was observed in the descriptive research is already available. What needed to be done by a researcher was to retrieve the information with the help of the various research methods which could include either the use of tests, or questionnaires or interviews or observation. The primary intention of descriptive study is to describe the phenomena to be studied systematically.

Participants of the Study - In this study, a questionnaire survey was conducted among 390 employees in the coal industry. Each company selected 78 respondents using a quota sampling. The selection criteria for respondents were as follows: first, the representativeness of the enterprises, with five representative coal companies in Shanxi Province being chosen, covering various ownership types and enterprise sizes; second, job diversity, including different management positions, absenteeism, technicians, and engineers; third, geographical representation, covering the main coal-producing areas in Shanxi Province; and finally, voluntary participation, with employees who were willing to participate in the survey being selected.

Data Gathering Instrument - The study mainly used questionnaire to gather relevant data. Items per instrument were presented as descriptive statements and the respondents rated how frequently they apply on a four-point Likert scale as a 3.50–4.0 scale means strong agreement, 2.50–3.49 means agreement, 1.50–2.49 scale means disagreement, and 1.00–1.49 rating scale means strong disagreement. Self-made questionnaire and has 3 parts. Part I of the questionnaire is industry innovation, which contains 15 items: green innovation ability (5 items), green innovation technology (5 items), green organization identity (5 items). Part II is about corporate social responsibility, with 15 items. There are 5-environmental responsibility, 5-social responsibility, and 5-economic responsibility. Part III is risk management, consisting of 15 items: risk identification and assessment (5), risk treatment (5), risk communication and reporting (5).

Table 1
Reliability Test Result using Cronbach Alpha and its Interpretation

Indicators	No. of Items	Cronbach Alpha	Remarks
Green Innovation Ability	5	0.953	Excellent
Green Innovation Technology	5	0.946	Excellent
Green Organization Identity	5	0.940	Excellent
Environmental Responsibility	5	0.934	Excellent
Social Responsibility	5	0.934	Excellent
Economic Responsibility	5	0.956	Excellent
Risk Identification and Assessment	5	0.949	Excellent
Risk Treatment	5	0.933	Excellent
Risk Communication and Reporting	5	0.937	Excellent

George and Mallery (2003) provide the following rules of thumb: “ $\geq .9$ –Excellent, $\geq .8$ –Good, $\geq .7$ –Acceptable, $\geq .6$ –Questionable, $\geq .5$ –Poor, and $< .5$ –Unacceptable”

A pilot survey was done to find out if the survey questionnaire worked. The survey questionnaires for 30 samples were tested for reliability with Cronbach's alpha using SPSS 28. Table 1 presents the results from the

reliability test for each variable found in our research.

Data Gathering Procedure - After the title of the paper is approved, the researcher obtained authorization from the organization's head and the personnel department of the coal company. After approval, researchers distributed the questionnaire to the study participants via email and other communication platforms commonly used by respondents, either through mailed paper questionnaires or Google forms. At the same time, the respondents were assured that data would be treated anonymously, and the data they provided would be kept confidential and used only for this study. In addition, the questionnaire was completed with sufficient time and genuine willingness. The responses to the survey items were collected and summarized, and then statistically analyzed and interpreted by university statisticians.

Data Analysis - The data analysis used weighted average and ranking to evaluate the industry's innovation capability from three aspects: green innovation ability, green technology innovation, and the organization's attitude towards green transformation. It also evaluated the company's environmental, social and economic responsibilities, and described the company's risk management practices in risk identification and assessment, risk handling, risk communication and reporting. As shown from the Shapiro-Wilk Test Result, all the p-values for the individual variables is less than 0.05 which means that the data-set is not normally distributed. Thus, Spearman rho was used along with the non-parametric tests to identify the significance of the relationship. all analyses were done in SPSS version 28.

Ethical Considerations - Based on the ethical moral code, the researcher asked for the corresponding information inquiry of every response before filling in the questionnaire and filled with the questionnaire after confirming, so as to guarantee the true data collected and the willingness of the response. Therefore, in this way, the researchers respected fully and valued their sincerity to gain genuine and valid information. This study was also carried out according to Article 1035 of the Civil Code of the People's Republic of China promulgated in May 2020. It states that the principle of legality, legitimacy and necessity shall be observed, and excessive treatment shall be forbidden.

1. Results and discussion

Table 2
Summary Table on Industry Innovation

Key Result Areas	Composite Mean	VI	Rank
Green Innovation Ability	2.70	Agree	1
Green Innovation Technology	2.64	Agree	2
Green Organization Identity	2.59	Agree	3
Grand Composite Mean	2.64	Agree	

Legend: 3.50-4.00=Strongly Agree; 2.50-3.49=Agree; 1.50-2.49=Disagree; 1.00-1.49=Strongly Disagree

From the summary results on the innovation practice, the score difference of these three sub variables is not very large, with Green Innovation Ability score 2.70, Green Innovation Technology score 2.64, and Green Organization Identity score 2.59. The ability of Green Organization Identity, Green Innovation Technology and Green Organization Identity to influence the green innovation practice of Shanxi coal enterprises is weakened in turn, and they are also closely related to them. Jia et al. (2021) pointed out that the practice level of green innovation is higher, the more conducive to the improvement of green product competitiveness, can not only improve the quality of the product to participate in the market competition, and provides opportunities to protect the environment, reduce pollution, to obtain a good reputation, to help enterprises to form unique resources, in order to further improve the competitiveness of enterprises. In addition, it is also pointed out that the corporate culture inclined to green innovation will have a subtle positive impact on employees' environmental awareness and innovation awareness, so that they will be encouraged to fulfill their environmental responsibilities, so as to carry out green innovation activities of enterprises.

Table 3

Summary Table on Corporate Social Responsibility

Key Result Areas	Composite Mean	VI	Rank
Environment Responsibility	2.57	Agree	3
Social Responsibility	2.70	Agree	1
Economics Responsibility	2.64	Agree	2
Grand Composite Mean	2.64	Agree	

Legend: 3.50-4.00=Strongly Agree; 2.50-3.49=Agree; 1.50-2.49=Disagree; 1.00-1.49=Strongly Disagree

Table 3 shows that the comprehensive result of CSR as a whole is 2.64 out of which CSR has the values of social responsibility (2.70), environmental responsibility (2.57) and economic responsibility (2.64) respectively. The surface respondents basically supported the responsibility of Shanxi Coal enterprises. Corporate social responsibility is an ethical and moral mechanism, which stresses that companies should be morally responsible for (Amato et al., 2023). Corporate social responsibility is a combination of corporate social responsibility and organizational awareness of social responsibility and social responsibility behavior, which aims to promote some of the organization's social interests (Aguinis et al., 2021). According to Abbas (2020), corporate social responsibility is an organization's green strategy which is capable of protecting the environmental, social, and economic stability.

Table 4

Summary Table on Risk Management Practices

Key Result Areas	Composite Mean	VI	Rank
Risk Identification and Assessment	2.62	Agree	2
Risk Treatment	2.67	Agree	1
Risk Communication and Reporting	2.61	Agree	3
Grand Composite Mean	2.63	Agree	

Legend: 3.50-4.00=Strongly Agree; 2.50-3.49=Agree; 1.50-2.49=Disagree; 1.00-1.49=Strongly Disagree

As shown in Table 4, risk management 2.67, ranked first; Risk identification and risk management 2.62, ranked second; risk of communication and reporting 2.61, ranked third with an average of 2.63. Shanxi coal enterprises need to actively manage risks to help managers identify and evaluate risks for more intelligent and efficient decision-making; lower enterprise production and operation costs, adapt to changing market conditions, and maintain comparative advantages. Handling the risk event actively and properly, adding to the internal control to prevent loss due to the risk event must always improve employees' risk awareness and collaborate with stakeholders to seek for the win win of economic and social as well as environmental gains. Naseem et al.(2020) mentioned that risk management enables an enterprise to manage different types of risks in a comprehensive and overall manner, with more focus on the management of all types of risks as well as on the process of creating value.

Table 5 presents the association between the various dimensions of the innovation practices and the CSR, as seen through the rho (correlation coefficient) and the correlation p-values. The correlation coefficients are between 0.555 and 1. All the coefficients are at 0.01 level of significance. The results show that there is a positive relationship between green innovation capacity, green innovation technology, green organization identity and corporate social responsibility, corporate environmental responsibility, corporate social responsibility and corporate economic responsibility. The closer the correlation coefficient is to 1, the stronger the positive correlation, that is, with the increase of innovative behavior, CSR increases. A p - value smaller than 0. 001 means we have very high confidence in the correlation results we found, which implies it is unlikely to be the result of random chance.

In general, there is a strong relationship between corporate innovation and CSR which can be seen from a p value < 0.001. first is that innovation practices encourage firms to assume their social responsibility; As Wang et al. (2021) suggests that companies who pro-actively engage in corporate innovation capabilities, green innovation technologies and green organizational identity tend to have higher corporate social responsibilities

like social, economic and environmental responsibilities. The innovation practice can help enterprises improve corporate image and competitiveness, reduce business operation cost, broaden market access, promote environmental investment, encourage greener patent applications and authorizations, support employees' engagement and satisfaction, encourage stakeholders' engagement, and encourage corporate innovation culture. Understanding its own connection to the innovation of practice and corporate social responsibility, which will allow companies to understand and adopt environmental protection and the sustainable concept and methods. In terms of technology, products and services will be able to save money, to create more value for the society, create a good corporate image and improve the reputation of the company.

Table 5
Relationship Between Industry Innovation and Corporate Social Responsibility

Green Innovation Ability	rho	p-value	Interpretation
Environment Responsibility	0.555**	<.001	Highly Significant
Social Responsibility	0.562**	<.001	Highly Significant
Economics Responsibility	0.556**	<.001	Highly Significant
Green Innovation Technology			
Environment Responsibility	0.571**	<.001	Highly Significant
Social Responsibility	0.566**	<.001	Highly Significant
Economics Responsibility	0.615**	<.001	Highly Significant
Green Organization Identity			
Environment Responsibility	0.581**	<.001	Highly Significant
Social Responsibility	0.560**	<.001	Highly Significant
Economics Responsibility	1.000**		Highly Significant

** . Correlation is significant at the 0.01 level

From this all-around analysis, it is clear that the enterprise innovation practice can promote enterprises for fulfilling the social responsibility. A positive correlation coefficient indicates that those enterprises with such green innovation practices have set a path for other enterprises to create a positive and responsible corporate social image, increase brand value, and promote the development of enterprises towards sustainability, enhance enterprise social responsibility, guide employee behavior, and enhance the efficiency of enterprises. Secondly, with the increasing importance of innovation practices for the continuous growth of enterprises, the more likely it is for the enterprise to be more willing to fulfill its own social responsibilities, making the enterprise last and stronger competitiveness.

These correlations show that the connection between innovation practices and CSR is strong, dependable. These results are of great meaning to Shanxi coal enterprises. Wang et al. (2023) pointed out, the importance of strengthening the environment management performance of the enterprise, and investing in innovative practice development projects, which focus on green innovation capability, green innovation technology, and green organization identity to enhance the enterprise's ability to respond to risk, innovative practice can direct companies' production and operations as well as to improve economic benefits by optimizing product, and nurture an environment conducive to innovation and a lasting development.

Generally speaking, recognizing the relationship between innovation practice and corporate social responsibility is necessary for Shanxi coal enterprises, with an eye on effective and sustainable development in the competitive environment of related resources enterprise. Shanxi coal enterprises that do innovative practice investment are more likely to have a high social responsibility, and the enterprises have a high reputation, brand value, and comprehensive benefits.

Table 6 presents the correlation between all the different facets of the innovation practice and the risk management practice according to the table with the Rho values and the P-Value. Correlation coefficients were between 0.575-0.649, all significant at 0.01. These results show us that there exists a positive correlation between innovation practice and risk management practice in Shanxi coal enterprises. The closer the correlation coefficient is to 1, the stronger the positive correlation. In this case, the risk management of the enterprise is also enhanced. When the p-value is less than 0.001, there is an observed correlation, meaning, these correlation results would be very unlikely if they occurred by random chance.

Table 6*Relationship Between Industry Innovation and Risk Management Practices*

Green Innovation Ability	rho	p-value	Interpretation
Risk Identification and Assessment	0.592**	<.001	Highly Significant
Risk Treatment	0.631**	<.001	Highly Significant
Risk Communication and Reporting	0.575**	<.001	Highly Significant
Green Innovation Technology			
Risk Identification and Assessment	0.575**	<.001	Highly Significant
Risk Treatment	0.649**	<.001	Highly Significant
Risk Communication and Reporting	0.606**	<.001	Highly Significant
Green Organization Identity			
Risk Identification and Assessment	0.577**	<.001	Highly Significant
Risk Treatment	0.578**	<.001	Highly Significant
Risk Communication and Reporting	0.582**	<.001	Highly Significant

***. Correlation is significant at the 0.01 level*

Generally, there is a very strong relationship between innovation practices and risk management practices as indicated by a p value <0.001. First, we can know that innovative practices for coal companies' risk management practices of identifying the risk, evaluating the risk management practice, and risk communication and report. implementing an innovation practice of a coal enterprise may also be more likely to identify environmental, social and governance-related risks, and adopt new risk management methods and strategies, a more flexible and sustainable business model, and improve the capacity of the enterprise to bear risk, the level of risk prevention and control technology, and the full participation of risk management, which in turn can promote the risk management practice of the coal enterprise. Second, the fact of this connection demonstrates how important it is to follow piercing practice in order to strengthen risk management practice: Through the implementation of the innovative practice of enhancing enterprises' green innovation capability, improving green innovation technology and enhancing the identification of green organizations, coal enterprises can improve their risk management practices and respond better to the constantly changing market environment.

In this exhaustive analysis, the role of creative practices on enhancing Enterprise Risk Management practices is pointed out. According to Yang et al. (2023), coal companies that adopt innovative practices can better enhance their environmental risk management capability, increase their market risk management capability, improve their operational risk management, promote the coordination and innovation of risks, and enhance their sustainable risk management capabilities. Moreover, through repeated innovation practices, coal enterprises are also more likely to improve their reputation in their field and meet the market demand for environmentally friendly products, create new sources of income, and encourage coal enterprises to enhance production capacity, allowing them to work together on different departments and fields. It is hoped that it will further promote the transformation of enterprises.

Also, due to the substantial value of these correlations indicates that there is a strong and stable relationship between the innovation practices and the risk management practices. They have significant implications for Shanxi coal enterprises and point to the need for Shanxi coal enterprises that practice innovation activities to be good at environmental management. As Wang et al.,(2022) show, understanding and using this relationship will greatly lower the chance of environmental pollution and ecological damage for coal companies, create more kinds of eco-friendly coal goods and ways that people want, cut down how much power is used and gas given off, deal better with big changes in the energy market, and stay stronger than others, Generally speaking, knowing about the connection between changing something into what it is now and figuring out what risks there are when running a coal business is very important for Shanxi coal companies that want to keep doing well as the coal field changes and has lots of competition. Through the implementation of innovation practice, companies can better take risks in the process, improve their own environmental performance, and provide a good guarantee for the long-term and stable development of enterprises.

Table 7*Relationship Between Corporate Social Responsibility and Risk Management Practices*

Environment Responsibility	rho	p-value	Interpretation
Risk Identification and Assessment	0.556**	<.001	Highly Significant
Risk Treatment	0.569**	<.001	Highly Significant
Risk Communication and Reporting	0.558**	<.001	Highly Significant
Social Responsibility			
Risk Identification and Assessment	0.613**	<.001	Highly Significant
Risk Treatment	0.593**	<.001	Highly Significant
Risk Communication and Reporting	0.596**	<.001	Highly Significant
Economics Responsibility			
Risk Identification and Assessment	0.577**	<.001	Highly Significant
Risk Treatment	0.578**	<.001	Highly Significant
Risk Communication and Reporting	0.582**	<.001	Highly Significant

***. Correlation is significant at the 0.01 level*

Table 7 shows the relationship between each dimension of CSR and risk management practice, which can be seen from the correlation coefficient (rho), and the corresponding P-value. R's were between 0.556 - 0.613, all were statistically significant at $p < 0.01^*$. The above finding shows that the environmental, social and economic responsibility— has a strong, positive association with the components of risk management practice, such as the identification and assessment of risk, the management of risk, and the communication and reporting of risk. Correlation co-efficient is around one, the correlation strength of positive correlation increases as CSR improves then the implementation of risk management would increase accordingly. All the p-values of the correlations was less than 0.001, meaning that there is a high level of confidence in the relationships observed, it is likely that they occurred by chance

In general, there is an existence of significant relationship between CSR and innovation management with the p - value $< .001$. First is to point out the importance of CSR in the promotion of risk management: Li et. al.,(2021) showed that enterprises' performance in environmental responsibility, social responsibility and economic responsibility can play a positive role in reducing environmental risks, promoting sustainable development, enhancing the awareness of risk management, reducing the impact of reputation risks, promoting stakeholders to cooperate, promoting the rationality of investment decisions, and enhancing market competitiveness, providing reference for the enterprise's risk management practice. The second is to emphasize the role of these correlations when it comes to integrating resources in the coal industry, in line with corporate social responsibility, through various forms of environmental protection, and with the help of green production methods, to promote clean energy production, care for employees, participate in public welfare work, and maintain a long-term stable relationship between stakeholders and employees, and also to increase the staff's sense of belonging and attachment to the company, as well as improve the quality of the company's products and reduce some costs by taking reasonable and effective actions, so as to achieve the company's risk management practice and better adapt to the quickly changing market demands.

The analysis points out the role of CSR in prompting enterprise risk management. It can be seen from the research of Gao et. al (2023) said that as enterprises proactively assume environmental, social and economic responsibilities and fulfill their corporate social responsibilities, it's much more likely to raise up the level of risk management practices. Furthermore, as the performance of corporate social responsibility gets better, it benefits enterprises to avoid risk, to gain benefit, to reduce risk loss, to reduce cost, to improve risk identification and evaluation capacity and so forth, which in turn improves the market competitive edge of enterprises and promote its long- term sustainable development.

Furthermore, the significant correlations shows that the relationship between CSR and risk management practices is significant and strong. This is very important to the Shanxi coal companies. They should be more responsible as a company. They should also pay attention on the change of society and people's needs. They should pay more attention to their employees' sense of responsibility and teamwork, and concern about the environmental protection, social welfare and other issues. understanding and use of this relationship can be more

comprehensive to identify and evaluate risk in risk management, make a more accurate, more timely decision, deal with all kinds of potential risks, cultivating staff responsibility consciousness, risk awareness, improve employee participation in risk management and implementation, achieve long-term stable development.

In general terms, it is significant for coal-related businesses in searching sustainable development in the mutable coalfield to recognize CSR-related risk management practices. Enterprises can do better job on risk management and improve overall performance by actively fulfilling CSR .

Research Output



Figure 1. Environmental Management Performance Framework

Figure 1 presents an environmental management performance framework that proposes a holistic and reliable solution to help coal enterprises in Shanxi province integrate environmental performance management into their overall production management work process. Recognizing the relationship between industrial innovation and enterprise social responsibility, enterprise risk awareness etc., also serves as a reasonable development route for coal enterprises to win at a sustainable competition with continuous innovative social responsibility and improved risk awareness. Industry innovation, seen as the main engine of a company's development, is considered an important support for companies to fulfill their social responsibilities by industry experts. And improve company risk management capability. Companies can provide more environmentally friendly and efficient products and services when they increase their green innovation abilities, technologies, and form a green company identity. By doing so, they can build a reputation for being environmentally responsible and being accountable. They need to be able to identify, assess, manage and communicate as well as report possible risks. For business entities, it is necessary for companies to enhance economic efficiency, boost market competition ability, and achieve sustainable development at the same time; the concept of corporate social responsibility also combines the aspects of environment, society, and economy inside and outside the company. In the inner side, it could improve the employee satisfaction and loyalty which could also bring the company more economic gains. Externally, it emphasizes sustainable ecological environment, reduces the environmental load and strives for a stable economic, social and environmental benefits. Coal companies could improve their ability to respond to social tasks and handle risks via ongoing industrial innovation, technological development, and being recognized as green organizations. These attributes are important for ongoing development.

To effectively use this framework, coal companies must understand their own situation in three aspects first: it also looks at the degree of industrial innovation, it analyses existing CSR practices and assesses the capabilities of an organization regarding risk identification and evaluation, risk management and risk communication and reporting According to the evaluation results of these, coal companies can think up special strategies for getting better in various areas For example, in the case of industrial innovation, enterprises can use the intelligent mining systems driven by AI to monitor the vibration frequency of equipment and energy consumption fluctuations in real time, predict coal cutter failures, and reduce downtime losses by 15%. They can also use digital twin technology to simulate the stress of the tunnel surrounding rock and improve the support plan to avoid wasting resources After conducting an evaluation of CSR activities, enterprises can work with research institutions to develop biological nano-dust suppressants for coal mines, reduce PM2.5 by 40%, and

provide clean stoves for free in communities surrounding the area through community co-construction programs. In the realm of risk management, companies have set up the three-step mechanism: “technological breakthroughs → social benefits → capital support.”

3. Conclusions and recommendations

The respondents generally agreed on the industry innovation in terms of green innovation ability, green innovation technology and green organizational identity. The respondents generally agreed on the corporate social responsibility in terms of environmental responsibility, social responsibility and economic responsibility. The respondents generally agreed on the risk management practices as to risk identification and assessment, risk treatment and risk communication and reporting. A high significant relationship was found among industry innovation, corporate social responsibility, and risk management. An environmental management performance framework was developed for coal enterprises in Shanxi Province, China.

Enterprises may establish a special innovation fund to invest in environmental technology research and development, enhance industrial innovation efficiency, and build an environmentally responsible corporate image. Department heads may adopt green-driven decision-making, form green technology teams, establish a continuous improvement environmental management system, and set up an information sharing platform to enhance internal communication and introduce strategic evaluations. Human Resource Department may improve the employee welfare system and compensation structure, encourage active participation in corporate projects, raise environmental awareness, and foster a less stress free working environment. Management teams at coal companies in Shanxi Province may consider how to adopt or integrate the proposed framework into their operations. Future researchers may deepen and broaden the scope of the study by expanding geographical scope, widening industry focus and conducting longitudinal studies.

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