

Human Resource Management Strategy in Implementing Occupational Safety and Risk Mitigation in Coal Mining

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Abstract. *Analyzing existing literature and case studies, it is clear that a critical need for HR strategies to prioritize safety culture, employee training, and proactive risk management is essential. Key aspects include tailored recruitment and selection processes to identify candidates with a strong safety mindset, ongoing training programs to enhance competency and awareness, and the establishment of a safety-centric organizational culture. Additionally, this study examines the integration of technology and data analytics into HR practices within the coal mining sector. The use of modern technology for personnel training, real-time monitoring, and predictive analytics is discussed as a means to preemptively identify potential safety risks and proactively address them. The importance of fostering communication and collaboration among employees, with an emphasis on the role of HR in facilitating a culture of transparent and open reporting, is highlighted. The findings of this study contribute to a deeper understanding of the multifaceted role HR plays in promoting safety and mitigating risk in the coal mining industry. As the industry continues to evolve, implementing innovative HR strategies is imperative for organizations seeking to maintain a safe and resilient operating environment while safeguarding the well-being of their workforce. The mining sector also has significant social and environmental impacts. Exploitation of natural resources often leads to severe environmental damage, such as deforestation, water and soil pollution, and biodiversity loss. These environmental impacts threaten not only the sustainability of ecosystems but also the health and livelihoods of local communities.*

Keywords: *Human; Management; Safety and Risk Mitigation; Strategy.*

1. Introduction

The coal mining industry is known for its inherent operational risks and complex safety challenges, which require a robust Human Resource Management (HRM) strategy for effective safety measures and risk mitigation. This comprehensive study explores the evolving landscape of Human Resource (HRM) practices within the coal mining sector, focusing on their critical role in enhancing mine safety and the environment. The study investigates the dynamic nature of the coal mining industry, identified by its hazardous working environment, complex technological processes, and global workforce.

Analyzing existing literature and case studies, it is clear that a critical need for HR strategies to prioritize safety culture, employee training, and proactive risk management is essential. Key aspects include tailored recruitment and selection processes to identify candidates with a strong safety mindset, ongoing training programs to enhance competency and awareness, and the establishment of a safety-centric organizational culture. Additionally, this study examines the integration of technology and data analytics into HR practices within the coal mining sector. The use of modern technology for personnel training, real-time monitoring, and predictive analytics is discussed as a means to preemptively identify potential safety risks and proactively address them.

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The coal industry is known for its complex and high-risk operational environment, involving a wide range of activities (Thuyet et al., 2007). This industry is characterized by hazardous processes, heavy machinery, and extreme working conditions, making safety and risk mitigation crucial (Dahl & Kongsvik, 2018). Safety and risk mitigation are crucial in the coal industry due to the potential for catastrophic accidents, environmental damage, and loss of human life (Dahl & Kongsvik, 2018). This industrial operation involves various risks, including process safety, occupational safety, and environmental safety, which require effective safety management strategies (Khan et al., 2015). ESDM data explains that the majority of occupational accidents in the mining industry occur at surface mines, as shown in the following figure.

2. Research Methods

This research is a quantitative study using a survey method to obtain respondents' perceptions of the issues raised. The research design for the issues raised is categorized as causal research, namely examining whether a safety culture and proactive risk management can be implemented in compliance with mining and environmental safety and whether compliance with safety can achieve the safety of mining and environmental human resources.

The data used in this study is primary data, data collected from the results of respondents' questionnaire answers, where the respondents in this study are remote area employees of PT Semesta Alam Barito with the number of respondents as determined in this study's sample.

3. Results and Discussion

3.1. Description of Research Object

This research was conducted at PT. Semesta Alam Barito, a coal mining company that carries out exploration, mining, transportation, processing, and shipping of coal. In carrying out its operational activities, the company involves human resources from various fields of work, such as heavy equipment operators, mechanics, field supervisors, occupational safety and health (K3) personnel, mining engineering personnel, and administrative personnel. All of these operational activities have a high level of risk, thus requiring effective human resource management and the implementation of an integrated occupational safety system.

PT. Semesta Alam Barito places human resources as a strategic asset that plays a vital role in maintaining productivity, occupational safety, and the sustainability of the Company's operations. Therefore, the Company implements a human resource management strategy that includes recruitment, selection, and placement of workers according to competency, training, employee development, performance appraisals, and fostering work discipline. This strategy aims to ensure that every worker has technical competence, an understanding of

occupational safety procedures, and the ability to identify and control risks that arise during mining operations.

In supporting the implementation of occupational safety, PT. Semesta Alam Barito implements the Mining Safety Management System (SMKP) as regulated in the laws and regulations in the mineral and coal mining sector. The implementation of this system is carried out through the preparation of occupational safety policies, hazard identification, risk assessment, risk control, preparation of standard operating procedures (SOP), use of personal protective equipment (PPE), safety inspections, internal audits, incident reporting, and periodic safety performance evaluations. All of these programs are implemented to create a safe, healthy and accident-free work environment.

The Company also develops a safety culture as part of its human resource management strategy. This safety culture is realized through safety induction for new employees, pre-job safety briefings, toolbox meetings, emergency response training, evacuation simulations, and regular safety campaigns. Furthermore, the Company encourages the active participation of all employees in reporting unsafe conditions and unsafe acts as a form of workplace accident prevention.

Risk mitigation strategies at PT Semesta Alam Barito are implemented systematically by identifying potential hazards at every stage of mining activities, from land clearing, drilling, blasting, excavation, loading, transportation, to heavy equipment maintenance activities. The company conducts a risk analysis to determine the level of likelihood and impact of each potential hazard, then establishes control measures according to the risk control hierarchy, namely elimination, substitution, engineering, administrative control and the use of personal protective equipment. This approach aims to reduce the possibility of workplace accidents, occupational diseases, equipment damage and disruption to the continuity of the company's operations.

In addition to technical aspects, the Company also implements a human resource management strategy focused on improving safety awareness and behavior for all employees. This strategy is implemented through competency training programs, operator certification, safety procedure compliance evaluations, awards for employees with good safety performance, and sanctions for safety procedure violations. This approach is expected to foster a work culture that is disciplined, responsible, and focused on preventing workplace accidents.

The implementation of a human resource management strategy integrated with occupational safety and risk mitigation programs demonstrates PT. Semesta Alam Barito's commitment to protecting its workforce while simultaneously improving the Company's operational effectiveness. The Company's success in managing its human resources is measured not only

by achieving production targets, but also by its ability to create a safe work environment, reduce the number of workplace accidents, increase compliance with mining safety standards, and maintain sustainable operational continuity.

PT. Semesta Alam Barito was chosen as the research location because this company has operational characteristics that are in line with the research focus, namely the implementation of human resource management strategies in the implementation of occupational safety and risk mitigation in the coal mining industry. This condition allows researchers to obtain a comprehensive picture of the planning, implementation, supervision and evaluation of human resource management strategies in supporting the creation of an effective occupational safety system and sustainable risk management in the mining environment.

3.2. Data Description

1. Respondent Characteristics

This study involved 266 respondents from PT Semesta Alam Barito, comprising management, technical, and non-technical positions. The respondent profile, including age, gender, and job title, is presented in detail in the following section.

a. Respondent Age

Table Respondent's Age

Age	Frequency	Percentage (%)
< 20 years	51	19.17%
20-30 years	82	30.83%
31-40 years	64	24.06%
41-50 years	56	21.05%
> 50 years	13	4.89%
Total	266	100%

Source: Processed Primary Data, 2026

Based on Table, the characteristics of respondents based on age show that the majority of PT. Semesta Alam Barito employees are in the productive age range. The 20-30 year age group has the largest percentage, namely 30.83%, followed by the 31-40 year age group at 24.06%, the 41-50 year age group at 21.05% and the age group under 20 years at 19.17%. Meanwhile, the age group over 50 years has the smallest percentage, namely 4.89%. The composition of these age groups shows that the majority of the Company's workforce is in the productive age, thus supporting the implementation of mining operational activities that require physical condition, adaptability and understanding of the application of occupational safety and risk mitigation in the PT. Semesta Alam Barito environment.

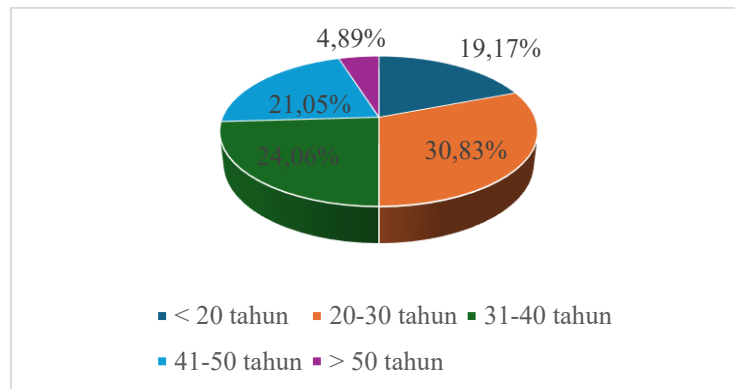


Figure Respondent Age (%)

Source: Processed Primary Data, 2026

b. Gender

Table Respondent's Gender

Gender	Frequency	Percentage (%)
Man	237	89.10%
Woman	29	10.90%
Total	266	100%

Source: Processed Primary Data, 2026

Based on Table. Respondent characteristics based on gender show that the majority of PT. Semesta Alam Barito employees are male with a percentage of 89.10%, while female respondents have a percentage of 10.90%. This composition shows that the workforce at PT. Semesta Alam Barito is dominated by men which is in line with the characteristics of the coal mining industry which generally involves operational work in the field with physical demands and a high level of work risk. The dominance of the male workforce reflects the company's need for human resources capable of supporting the implementation of operational activities, work safety and risk mitigation effectively in the mining environment.

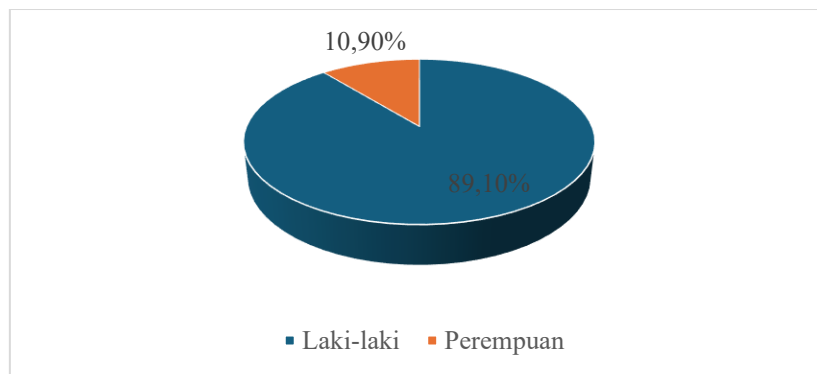


Figure Respondent Gender (%)

Source: Processed Primary Data, 2026

c. Job Position

Table Respondent's Job Position

Job position	Frequency	Percentage (%)
Management	33	12.41%
Technical	139	52.26%
Non-Technical	94	35.34%
Total	266	100%

Source: Processed Primary Data, 2026

Based on Table. Respondent characteristics based on job position show that the majority of PT. Semesta Alam Barito employees occupy technical positions with a percentage of 52.26%, followed by non-technical positions at 35.34%, while management positions have a percentage of 12.41%. This composition shows that the Company is dominated by workers directly involved in coal mining operational activities. The dominance of employees in technical positions reflects the high need for human resources who have operational competencies in supporting the mining process, so that the implementation of human resource strategies, occupational safety and risk mitigation is very important to ensure that every job is carried out in accordance with applicable operational standards and occupational safety provisions.

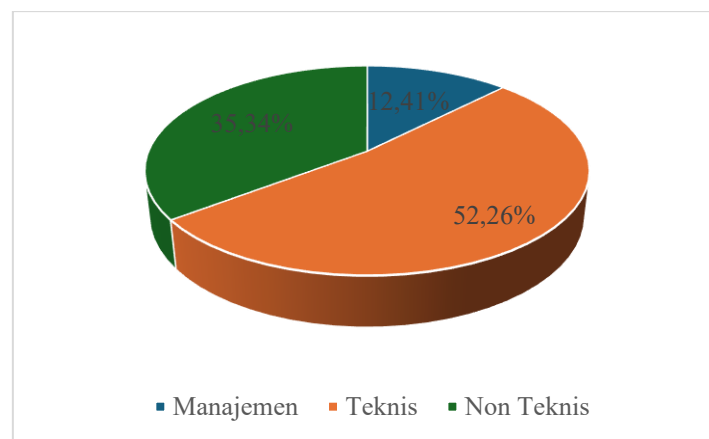


Figure Respondents' Job Position (%)

Source: Processed Primary Data, 2026

3.3. Analysis Results

The questionnaires were distributed to respondents using Microsoft Forms. After the questionnaires were answered and returned, the research instrument was tested. The testing was carried out in two stages: validity and reliability. After the instrument was declared suitable, it was analyzed using the SmartPLS application.

1. Measurement Model Analysis (Outer Model)

This study utilized SmartPLS 3.0 software through the Partial Least Squares (PLS) approach, a crucial step in latent construct-based quantitative research. The testing process included validity and reliability analysis, aimed at ensuring that the research instrument, the questionnaire, contained adequate measurement quality and was reliable.

a) Validity Test

Validity testing is conducted to assess the extent to which the items in a research instrument accurately reflect the intended construct. In this study, the validation process encompasses two main dimensions: convergent validity and discriminant validity. Convergent validity ensures that all indicators within a construct exhibit an adequate level of uniformity, while discriminant validity aims to establish clear distinctions between different constructs.

a. Convergent Validity

In general, determining indicator validity typically refers to a minimum loading factor value of 0.7. However, when designing new models or refining indicators, this threshold can be slightly relaxed, with the expectation that the value remains above 0.7. According to other references, a value above 0.6 is still considered adequate. Meanwhile, the Average Variance Extracted approach requires an AVE value greater than 0.5. The results of convergent validity testing obtained through loading factors and AVE are presented in the following table.

Table Validity Test Results

Variables	Indicator	Outer Loadings	Information
Safety Culture	BK1	0.804	Valid
	BK2	0.821	Valid
	BK3	0.802	Valid
	BK4	0.758	Valid
	BK5	0.784	Valid
	BK6	0.833	Valid
	BK7	0.824	Valid
	BK8	0.805	Valid
	KKK1	0.837	Valid

Work Compliance and Safety	KKK 2	0.804	Valid
	KKK3	0.851	Valid
	KKK4	0.851	Valid
	KKK5	0.860	Valid
	KKK6	0.824	Valid
	KKK7	0.802	Valid
	KKK8	0.739	Valid
	KKK9	0.749	Valid
	KKK10	0.830	Valid
Human Resources Safety	KSDM1	0.821	Valid
	KSDM2	0.856	Valid
	KSDM3	0.836	Valid
	KSDM4	0.807	Valid
	KSDM5	0.795	Valid
	KSDM 6	0.796	Valid
	KSDM 7	0.849	Valid
	KSDM 8	0.818	Valid

	KSDM 9	0.763	Valid
	KSDM10	0.852	Valid
Proactive Management Risk	MPR1	0.827	Valid
	MPR2	0.785	Valid
	MPR3	0.742	Valid
	MPR4	0.704	Valid
	MPR5	0.812	Valid
	MPR6	0.836	Valid
	MPR7	0.737	Valid
	MPR8	0.870	Valid
	MPR9	0.827	Valid
	MPR10	0.736	Valid

Source: Processed Primary Data, 2026

Based on the results of the convergent validity test using the outer loading value, it shows that all indicators of the safety culture, compliance and occupational safety, human resource safety, and proactive risk management variables have outer loading values above 0.70, ranging from 0.704 to 0.870. The safety culture variable has an outer loading value of 0.758 to 0.833, the compliance and occupational safety variable of 0.739 to 0.860, the human resource safety variable of 0.763 to 0.856, and the proactive risk management variable of 0.704 to 0.870. Hair et al. (2022) explained that an indicator is declared to meet convergent validity if it has an outer loading value of more than 0.70. Therefore, all indicators in this study are declared valid because they are able to reflect the measured construct well, so that all

indicators are worthy of being maintained and can be used in the structural model analysis stage (inner model).

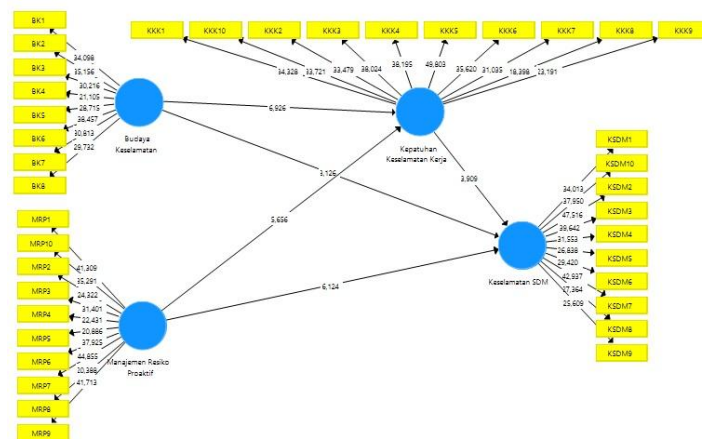


Figure Validity Test Model

Source: Processed Primary Data, 2026

Table Average Variance Extracted (AVE) Value

Criteria	Safety culture	Occupational safety	Human Resources Safety	Proactive risk management
AVE	0.647	0.666	0.672	0.623

Source: Processed Primary Data, 2026

Based on the findings obtained, the Average Variance Extracted value for each variable indicates that the four constructs in this study meet an AVE value exceeding 0.5. Thus, all constructs can be considered convergently valid and worthy of proceeding to the structural model analysis stage.

b. Discriminant Validity

Discriminant validity aims to ensure that each latent construct is truly capable explaining the indicators in a way more dominant compared to other constructs. Discriminant validity assessment is applied using three different techniques, namely cross-loading, the Fornell–Larcker criterion, and the Heterotrait–Monotrait Ratio. In the cross-loading approach, each indicator is expected to show a higher correlation with its original construct compared to other constructs. Meanwhile, the Fornell–Larcker criterion requires that the square root of

the Average Variance Extracted in each construct exceeds the correlation value with other constructs. In the Heterotrait-Monotrait Ratio method, a valid value is considered valid if it is below 0.90. The results of the discriminant validity evaluation are presented in detail in the following table.

Table Measurement Results ValueCross Loadings

Indicator	Safety culture	Occupational safety compliance	Human Resources Safety	Proactive Risk Management	Information
BK1	0.804	0.757	0.743	0.777	Valid
BK2	0.821	0.795	0.754	0.772	Valid
BK3	0.802	0.749	0.719	0.754	Valid
BK4	0.758	0.715	0.704	0.674	Valid
BK5	0.784	0.707	0.723	0.709	Valid
BK6	0.833	0.713	0.763	0.732	Valid
BK7	0.824	0.681	0.713	0.666	Valid
BK8	0.805	0.639	0.681	0.697	Valid
KKK1	0.772	0.837	0.773	0.794	Valid
KKK2	0.687	0.804	0.689	0.720	Valid
KKK3	0.757	0.851	0.722	0.726	Valid
KKK4	0.781	0.851	0.750	0.772	Valid

KKK5	0.759	0.860	0.768	0.734	Valid
KKK6	0.708	0.824	0.738	0.734	Valid
KKK7	0.735	0.802	0.742	0.701	Valid
KKK8	0.705	0.739	0.684	0.613	Valid
KKK9	0.631	0.749	0.687	0.676	Valid
KKK10	0.770	0.830	0.827	0.749	Valid
KSDM1	0.697	0.710	0.821	0.758	Valid
KSDM2	0.770	0.753	0.856	0.802	Valid
KSDM3	0.746	0.713	0.836	0.745	Valid
KSDM4	0.734	0.714	0.807	0.791	Valid
KSDM5	0.731	0.738	0.795	0.770	Valid
KSDM6	0.673	0.738	0.796	0.723	Valid
KSDM7	0.793	0.775	0.849	0.766	Valid
KSDM8	0.780	0.747	0.818	0.695	Valid
KSDM9	0.684	0.726	0.763	0.725	Valid
KSDM10	0.785	0.810	0.852	0.766	Valid
MRP1	0.744	0.735	0.748	0.825	Valid

MRP2	0.618	0.586	0.613	0.736	Valid
MRP3	0.684	0.707	0.708	0.785	Valid
MRP4	0.657	0.664	0.681	0.742	Valid
MRP5	0.556	0.574	0.603	0.704	Valid
MRP6	0.701	0.725	0.780	0.812	Valid
MRP7	0.787	0.737	0.796	0.836	Valid
MRP8	0.723	0.628	0.723	0.737	Valid
MRP9	0.813	0.795	0.792	0.870	Valid
MRP10	0.780	0.800	0.783	0.827	Valid

Source: Processed Primary Data, 2026

Based on the presented Cross Loadings analysis, it can be observed that each indicator indicates a stronger relationship with its original construct than with other constructs. This finding confirms that the indicators consistently represent the intended construct according to their respective columns.

Next, discriminant validity was analyzed by comparing the square root of the Average Variance Extracted value of each construct to the correlation coefficient between constructs in the model. If the square root of the AVE of a construct exceeds its correlation value with other constructs, the construct is considered to meet the requirements for discriminant validity. The results of the comparison of the square roots of the AVE for all constructs are presented in Table

Table Square Root Value of AVE (Fornell-Lacker) and Correlation Coefficient

Variables	Safety culture	Occupational safety compliance	Human Resources Safety	Proactive risk management
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Safety culture		0.897	0.903	0.900
Occupational safety compliance	0.897			
Human Resources Safety		0.906	0.820	
Proactive risk management		0.887	0.920	0.789

Source: Processed Primary Data, 2026

The results of the data analysis show that the square root of the Average Variance Extracted for each variable is partly higher or lower than the correlation coefficient between variables in the model. This condition indicates that the model does not fully comply with the discriminant validity criteria based on the AVE root. However, because the convergent validity and reliability tests have confirmed that all indicators and constructs are suitable for use, plus the evaluation of discriminant validity through Cross Loadings provides adequate evidence, and the AVE value is above the specified threshold, the use of the Partial Least Squares Structural Equation Modeling method can still be continued without obstacles.

Table Heterotrait Value – Monotrait Ratio (HTMT)

Item	HTMT Value	Information
Safety culture Human Resources Safety	0.965	Valid
Proactive risk management HR safety	0.977	Valid
Work safety compliance human resource safety	0.958	Valid

Source: Processed Primary Data, 2026

Based on Table, it can be explained that all constructs in this study meet the required parameters. Each indicator proves a higher loading value on the original construct compared to the loading on other constructs based on cross-loading testing. Meanwhile, through the Fornell-Lacker approach, the results prove that most constructs in the model can be distinguished from other constructs. The HTMT approach proves that all recorded values are at the maximum limit of 0.90, meaning that each construct has a clear empirical difference. The results of data processing indicate that this research model has met the requirements of discriminant validity, so the study can proceed to the next stage, namely the evaluation of the structural model and the assessment of the overall suitability of the model.

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b) Reliability Test

Reliability testing is used to evaluate the consistency of the questionnaire as a variable indicator. If the instrument can produce consistent results, it is considered reliable. In this research, Composite Reliability and Cronbach's Alpha were used to assess reliability. Ghazali & Latan (2015) explained that a value of ≥ 0.70 indicates that confirmatory research has good reliability, while a value between 0.60 and 0.70 is still acceptable for exploratory research. The results of the reliability test for the two measures are as follows:

Table Reliability Test Results

Variables	<i>Cronbach's Alpha</i>	<i>Composite Reliability</i>
Safety culture	0.922	0.936
Occupational safety compliance	0.944	0.952
Human Resources Safety	0.946	0.953
Proactive risk management	0.932	0.943

Source: Processed Primary Data, 2026

Table shows that all variables had Cronbach's Alpha and Composite Reliability above 0.7. This indicates that the instrument is reliable and consistent, thus ensuring that the measurement of each construct is reliable and ready for further analysis.

2. Descriptive Statistical Analysis

Descriptive statistical analysis was performed by dividing each construct into groups of mean value intervals. The formula used to calculate the frequency distribution is the following:

1.00 – 1.80 = very low

1.81 – 2.60 = low

2.61 – 3.40 = moderate

3.41 – 4.20 = high

4.21 – 5.00 = very high

4. Conclusion

Based on the research results and research discussion, the following conclusions can be drawn.

1. A safety culture and proactive risk management have been proven to improve compliance with mining and environmental safety. Test results indicate that safety culture has a positive and significant effect on safety compliance. These results indicate that the stronger the safety culture implemented by the company and the more optimal the implementation of proactive risk management, the higher the level of worker compliance in implementing safety procedures. Furthermore, safety compliance has also been shown to act as a mediator, strengthening the influence of proactive risk management and safety culture on the safety of mining and environmental human resources.
2. Occupational safety compliance has been proven to improve the safety of mining human resources and the environment. These results indicate that the higher the level of worker compliance with standard operating procedures, the use of personal protective equipment, and the implementation of occupational safety regulations, the higher the level of worker safety and the better the protection of the environment. Therefore, improving the safety of mining human resources and the environment can be achieved through the synergy between a strong safety culture, the implementation of continuous

proactive risk management, and high levels of occupational safety compliance as a concrete implementation of the Mining Safety Management System (SMKP).

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