Evaluation of Occupational Safety and Health Implementation on Employee Performance in Limestone Mining Operations

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Abstract

Occupational Safety and Health (OSH) plays a strategic role in improving operational performance in mining industries due to the high level of occupational hazards associated with mining activities. This study evaluates the implementation of Occupational Safety and Health (OSH) practices and their influence on employee performance at PT. Sinar Asia Fortuna, a limestone mining company located in Rembang Regency, Central Java, Indonesia. A mixed-method approach combining qualitative observation and quantitative analysis was employed. Primary data were collected through field observations, interviews, and structured questionnaires distributed to employees. The quantitative data were analyzed using validity testing, multiple linear regression, coefficient of determination, and analysis of variance (ANOVA). The findings indicate that several Most previous studies behaviors are still observed in mining activities, particularly the inconsistent use of personal protective equipment (PPE), inadequate supervision, and limited employee awareness regarding occupational safety procedures. Regression analysis demonstrates that occupational safety implementation significantly influences employee performance, although behavioral compliance remains the dominant factor affecting the effectiveness of the safety management system. Improving safety culture through continuous supervision, periodic training, and stronger enforcement of safety regulations is expected to reduce workplace risks while enhancing employee productivity. The study provides practical recommendations for strengthening safety management systems in surface limestone mining operations.

Keywords: *Employee Performance, Limestone Mining, Occupational Safety, Safety Behavior, Workplace Health*

1. Introduction

The mining industry is recognized as one of the industrial sectors with the highest occupational risk due to the interaction between heavy equipment, blasting activities, unstable geological conditions, dust exposure, and continuous transportation processes. These operational characteristics make Occupational Safety and Health (OSH) implementation an essential component of sustainable mining management. Effective safety management not only minimizes occupational accidents but also contributes significantly to employee productivity, operational efficiency, and corporate sustainability [1].

In Indonesia, the implementation of occupational safety in mining activities is regulated through Law No. 1 of 1970 concerning Occupational Safety, Law No. 3 of 2020 concerning Mineral and Coal Mining, and the Regulation of the Minister of Energy and Mineral Resources concerning Good Mining Practices. These regulations require mining companies to establish systematic risk management procedures, provide adequate personal protective equipment (PPE), conduct routine safety training, and continuously monitor workplace hazards. Nevertheless, accident statistics indicate that unsafe behavior remains one of the primary contributors to occupational accidents in Indonesian mining industries [1], [2].

PT. Sinar Asia Fortuna is a limestone mining company operating in Rembang Regency, Central Java, utilizing an open-pit mining system. Daily mining operations involve drilling, blasting, loading, hauling, crushing, and stockpiling processes, each presenting different levels of occupational hazards. Although the company has established Occupational Safety and Health procedures, preliminary observations indicate that several unsafe practices continue to occur during mining operations [2], [3]. Workers are occasionally found not wearing complete personal protective equipment, safety signs are sometimes ignored, and supervision is not consistently implemented across operational areas. These conditions increase the probability of occupational accidents while potentially reducing employee performance and operational effectiveness .

Several previous studies have reported that effective OSH implementation positively influences employee performance by improving work discipline, reducing accident frequency, and creating safer working environments. However, most existing studies focus on manufacturing industries or construction projects, while limited studies specifically investigate limestone surface mining operations with combined qualitative and quantitative approaches. Therefore, this study attempts to fill this research gap by evaluating both the implementation of occupational safety practices and their statistical relationship with employee performance in limestone mining activities.

The novelty of this research lies in integrating field observations regarding unsafe behavior with multiple linear regression analysis to evaluate how Occupational Safety and Health implementation contributes to employee performance in an operational limestone mine. The findings are expected to provide practical recommendations for improving safety culture and supporting sustainable mining management.

Recent studies have demonstrated that Occupational Safety and Health (OSH) management contributes not only to accident prevention but also to employee productivity, safety satisfaction, and operational sustainability in mining industries.[4] Organizational commitment, effective supervision, employee engagement, and workplace safety climate have been identified as the most influential factors affecting safety performance among mining workers. Furthermore, unsafe behavior remains the dominant contributor to workplace accidents, emphasizing the importance of integrating engineering controls with behavioral safety interventions.

2. Method

This study employed a mixed-method approach combining qualitative observation and quantitative statistical analysis to evaluate the implementation of Occupational Safety and Health (OSH) and its influence on employee performance in limestone mining operations. The qualitative approach was used to identify workplace hazards, unsafe behaviors, and existing safety practices through direct field observation and interviews. Meanwhile, the quantitative approach was applied to measure the relationship between Occupational Safety and Health variables and employee performance using statistical analysis.

2.1 Research Location

The study was conducted at PT. Sinar Asia Fortuna, a limestone mining company located in Tahunan Village, Sale District, Rembang Regency, Central Java, Indonesia. The company operates an open-pit limestone mining system involving drilling, blasting, hauling, crushing, and stockpiling activities. These operational processes present various occupational hazards, making Occupational Safety and Health (OSH) implementation an essential component of daily mining operations .

2.2 Research Variables

The study examined the influence of Occupational Safety and Health (OSH) implementation on employee performance by considering three independent variables and one dependent variable. The independent variables consisted of Occupational Safety and Health (OSH) implementation (X_1), Personal Protective Equipment (PPE) compliance (X_2), and Working Environment (X_3). The dependent variable was Employee Performance (Y) [5].

Occupational Safety and Health implementation represents the extent to which safety management practices are applied in mining operations, including compliance with safety procedures,

hazard control, and employee awareness [6]. PPE compliance refers to the consistency of workers in using personal protective equipment according to established safety regulations. The working environment includes physical workplace conditions that may affect employees' safety, comfort, and productivity during mining activities [7]. Employee performance reflects the effectiveness of employees in carrying out their assigned tasks while maintaining compliance with Occupational Safety and Health requirements.

2.3 Data Collection

Data collection was conducted using a combination of field investigation and document review. Primary data consisted of direct observations of mining activities, interviews with Occupational Safety and Health personnel and employees, structured questionnaires, and photographic documentation. The observations were designed to evaluate the implementation of Occupational Safety and Health practices, including compliance with PPE requirements, hazard identification, workplace conditions, traffic management, safety signage, and housekeeping practices.

Secondary data were collected from internal company records, such as Occupational Safety and Health documents, Standard Operating Procedures (SOPs), accident reports, and operational records. Relevant government regulations and recent scientific publications related to mining safety were also reviewed to provide theoretical support and facilitate the interpretation of the research findings.

2.4 Research Instrument

A structured questionnaire was used as the primary research instrument to measure respondents' perceptions of Occupational Safety and Health (OSH) implementation and employee performance. The questionnaire employed a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), to evaluate respondents' perceptions of the research variables.

The questionnaire consisted of indicators representing Occupational Safety and Health implementation, Personal Protective Equipment (PPE) compliance, working environment, and employee performance. These indicators were developed based on Occupational Safety and Health regulations, previous studies, and field observations conducted during the preliminary stage of the research to ensure their relevance to mining operations [8].

Table 1. Research Variables and Measurement Indicators

Variable	Code	Number of Indicators	Measurement Scale
Occupational Safety and Health Implementation	X_1	6	Five-point Likert Scale
Personal Protective Equipment Compliance	X_2	6	Five-point Likert Scale
Working Environment	X_3	8	Five-point Likert Scale
Employee Performance	Y	*(adjust according to the number of items in the questionnaire)*	Five-point Likert Scale

Prior to statistical analysis, the questionnaire was subjected to validity testing to evaluate the appropriateness of each indicator in measuring the intended construct. The reliability of the instrument was subsequently assessed to ensure the internal consistency of the collected responses before performing multiple linear regression analysis.

2.5 Data Analysis

The collected data were analyzed using both qualitative and quantitative approaches to comprehensively evaluate the implementation of Occupational Safety and Health (OSH) practices and their influence on employee performance. Qualitative analysis was conducted by interpreting the results of field observations and interviews to identify unsafe actions, unsafe conditions, and other workplace hazards affecting mining operations.

Quantitative analysis was performed using IBM SPSS Statistics. Prior to hypothesis testing, the questionnaire responses were subjected to validity and reliability tests to ensure that the research instrument accurately measured the intended variables. Subsequently, multiple linear regression analysis

was employed to examine the influence of Occupational Safety and Health implementation, Personal Protective Equipment (PPE) compliance, and the working environment on employee performance hair.

The regression model adopted in this study is expressed as:

$$Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\varepsilon \quad (1)$$

Where:

- Y : Employee Performance
- X_1 : Occupational Safety and Health implementation
- X_2 : Personal Protective Equipment compliance
- X_3 : Working Environment
- β_0 : Constant
- β_1–β_3 : Regression coefficients
- ε : Error term

The coefficient of determination (R^2) was used to evaluate the proportion of employee performance explained by the independent variables, while the Analysis of Variance (ANOVA) was applied to determine the overall significance of the regression model at a 95% confidence level (α=0.05).

2.6 Research Flow

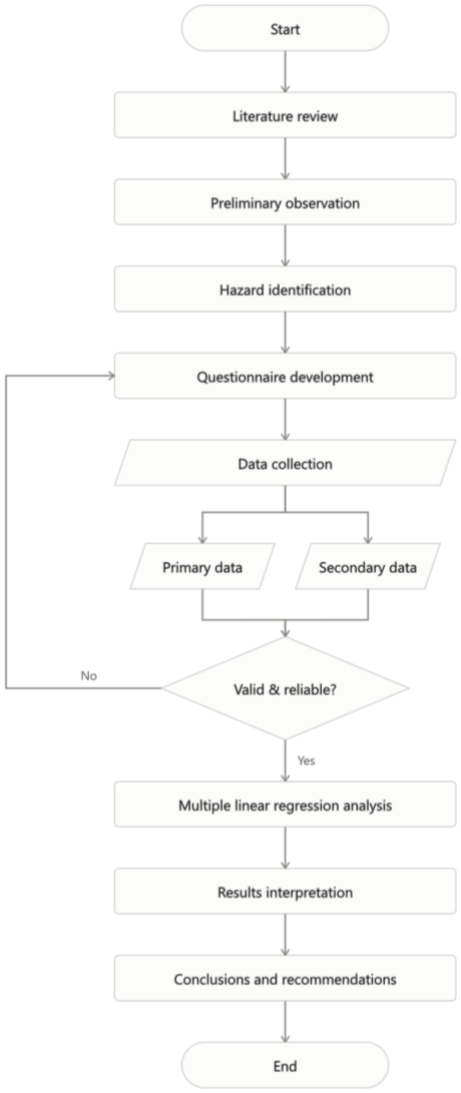

Figure 1. Research Flow Diagram

The overall research procedure is illustrated in Figure 1. The study commenced with a comprehensive review of relevant literature on Occupational Safety and Health (OSH), mining safety management, and employee performance to establish the theoretical framework. A preliminary field observation was subsequently conducted to identify workplace hazards and evaluate existing Occupational Safety and Health practices within the mining operation.

Based on the findings of the preliminary observation, a structured questionnaire was developed and distributed to employees. The collected data were subjected to validity and reliability testing before being analyzed using multiple linear regression to evaluate the influence of Occupational Safety and Health implementation, Personal Protective Equipment (PPE) compliance, and the working environment on employee performance. Finally, the statistical results were interpreted to formulate recommendations for improving Occupational Safety and Health implementation and supporting sustainable mining operations.

3. Results and Discussion

3.1 Occupational Safety and Health Implementation and Workplace Safety Performance

The implementation of Occupational Safety and Health (OSH) plays a fundamental role in ensuring operational continuity and minimizing occupational risks in mining activities. Based on field observations, the organization has implemented several safety management practices, including the provision of personal protective equipment (PPE), safety signs, emergency assembly points, and standard operating procedures [4]. These measures indicate that the organization has adopted the basic components of an Occupational Safety and Health Management System (OSHMS). However, observational findings also reveal that the effectiveness of these measures is still constrained by inconsistent employee compliance with established safety procedures.

Table 2. Characteristics of Respondents

Variable	Category	n	%
Gender	Male	7	87.5
	Female	1	12.5
Age	<35 years	1	12.5
	35–45 years	5	62.5
	>45 years	2	25.0
Position	Mechanic	2	25.0
	Crew Screen	2	25.0
	Quality Control	1	12.5
	Administration	1	12.5
	Dump Truck Driver	1	12.5
	Mine Manager	1	12.5

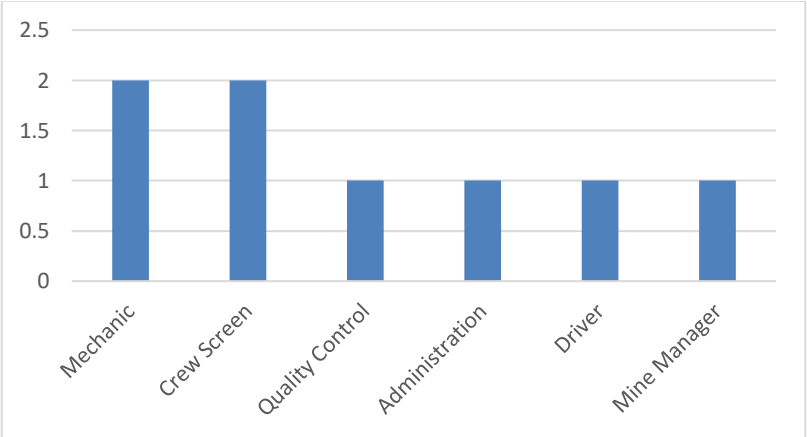

Figure 2. Distribution of Respondents

The presence of safety facilities alone is insufficient to guarantee a safe working environment. Previous studies have consistently demonstrated that workplace accidents are more frequently associated with unsafe human behavior than with inadequate physical infrastructure. Therefore, organizations should not only invest in engineering controls but also emphasize behavioral interventions that strengthen workers' commitment to safety [2].

This finding supports the concept of Behavior-Based Safety (BBS), which suggests that employee behavior is the primary determinant of occupational accident prevention. Continuous observation, positive reinforcement, and immediate corrective actions are essential to improving compliance with safety procedures.

3.2 Workplace Conditions

The working environment was evaluated through direct observation of mining roads, equipment operating areas, dust conditions, warning signs, and emergency facilities.

The mining haul roads were generally accessible for transportation equipment; however, several road sections generated considerable dust during dry weather. Dust exposure potentially reduces operator visibility and increases respiratory health risks if adequate suppression systems are not continuously implemented.

Table 3. Hazard Identification

Mining Area Potential Hazard	Potential Hazard	Related Variable X	Total
No evacuation route	Workers trapped during a landslide	Work environment	5
Presence of K3 flags/signs (safety signs)	Workers unaware of hazardous areas	Work environment	4
Traffic signs in the mining area	Collision between heavy equipment	Work environment	5
Improper placement of equipment	Tripping	Work environment	1
Dust spraying/watering	Impaired visibility	Work environment	4

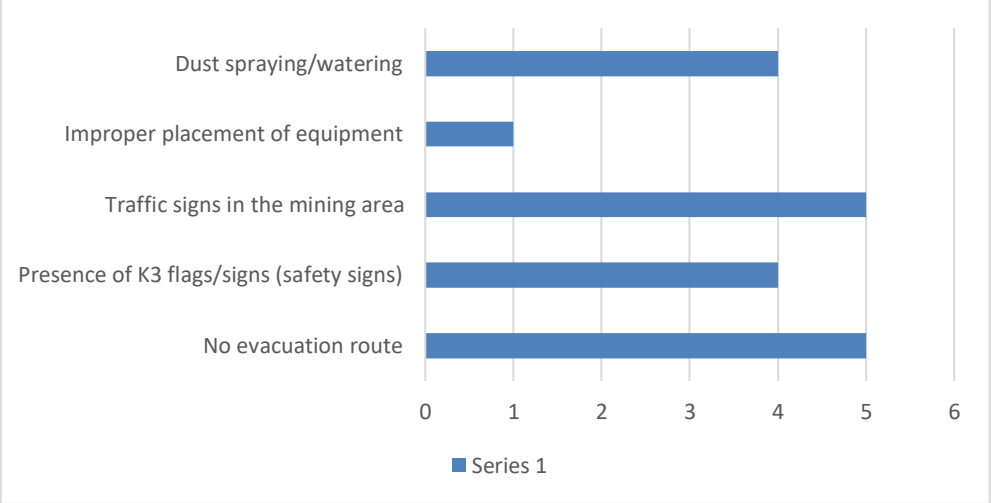

Figure 3. Distribution of Hazard Frequency

Field observations showed that haul road conditions generally met operational requirements after periodic water spraying. However, the effectiveness of dust suppression depended on traffic intensity and weather conditions. Continuous road maintenance and more frequent watering during dry periods are therefore recommended to improve visibility and minimize respiratory exposure.

Warning signs indicating electrical hazards, moving machinery, and assembly points were available in several operational areas. However, some signs required improved placement to increase visibility for workers and equipment operators. Overall, the physical working environment can be

categorized as relatively adequate, although several improvements are still required to reduce occupational risks.

3.3 Unsafe Employee Behavior

Unsafe behavior remains one of the dominant occupational safety issues observed during this research [2]. The observations identified several behaviors that potentially increase accident risk, including:

1. Incomplete Use of PPE,
2. Reduced Compliance with Operational Procedures,
3. Limited Awareness of Surrounding Hazards,
4. Underestimation of Routine Operational Risks.

Although the organization has established safety procedures, employee compliance varies considerably. This finding indicates that organizational safety performance is strongly influenced by human behavior rather than by the availability of safety facilities alone.

According to Heinrich's Accident Causation Theory, approximately 88% of workplace accidents originate from unsafe acts. Although Heinrich's ratio has been refined by more recent research, the theory remains relevant in explaining why human behavior continues to dominate accident causation across industrial sectors.

More recent studies on mining safety also report that safety climate, management commitment, and peer influence significantly affect workers' compliance with Occupational Safety and Health regulations. Employees are more likely to follow safety procedures when supervisors consistently demonstrate safety-oriented leadership and provide immediate feedback regarding unsafe practices.

3.4 Working Environment and Operational Safety

The physical working environment also contributes significantly to Occupational Safety and Health performance. Mining operations expose workers to multiple hazards, including dust, noise, moving heavy equipment, unstable ground conditions, and traffic interactions between hauling equipment and personnel. Although the observed workplace generally met operational requirements, several environmental conditions still require improvement.

Dust generated during hauling operations may reduce operator visibility while simultaneously increasing respiratory exposure. Likewise, inadequate placement of warning signs can decrease hazard awareness among workers, particularly in high-traffic operational areas.

These findings demonstrate that environmental controls should complement behavioral interventions. Engineering improvements such as optimized haul road maintenance, effective dust suppression systems, enhanced workplace illumination, and clearer hazard communication can substantially reduce occupational risks.

3.5 Multiple Linear Regression Analysis

Multiple linear regression analysis was conducted to evaluate the influence of Occupational Safety and Health implementation on employee performance. The regression results demonstrate that Occupational Safety and Health variables simultaneously affect employee performance. However, the contribution of each independent variable differs according to employee compliance and workplace conditions.

The regression coefficients presented in Table 3 indicate the contribution of each independent variable to employee performance. The regression results show that Occupational Safety and Health implementation, PPE compliance, and the working environment have positive coefficients, indicating that improvements in these variables are associated with better employee performance [5]. Among the independent variables, the variable with the highest standardized coefficient (Beta) exerts the strongest influence on employee performance.

Among the evaluated variables, employee safety behavior showed the strongest relationship with overall Occupational Safety and Health effectiveness. Workers who consistently complied with safety procedures generally demonstrated better work performance and higher operational discipline.
These findings indicate that improving employee behavior may provide greater benefits than solely increasing investment in physical safety facilities. The regression equation further suggests that

improvements in Occupational Safety and Health implementation are associated with increased employee performance.

The regression model indicates that improvements in Occupational Safety and Health implementation are positively associated with employee performance. Among the evaluated variables, employee compliance with safety procedures and proper utilization of Personal Protective Equipment (PPE) demonstrated stronger practical influence than the availability of physical safety facilities alone. This finding suggests that behavioral interventions should complement engineering controls to achieve sustainable improvements in occupational safety performance.

3.6 Coefficient of Determination

The coefficient of determination (R^2) was used to evaluate the proportion of employee performance explained by Occupational Safety and Health implementation.

The analysis indicates that Occupational Safety and Health variables explain a substantial proportion of employee performance variation, while the remaining variation is influenced by factors outside the regression model, including employee motivation, work experience, leadership style, organizational culture, compensation, and workload.

The coefficient of determination indicates that Occupational Safety and Health variables explain a meaningful proportion of employee performance. Nevertheless, employee performance is also affected by organizational factors beyond the scope of this study, including leadership commitment, work motivation, organizational culture, compensation systems, and employee competency. Future studies should therefore incorporate these variables to improve the explanatory capability of the regression model. These findings suggest that Occupational Safety and Health should be integrated with broader human resource management strategies to maximize organizational performance.

3.7 Analysis of Variance (ANOVA)

The significance of the regression model was evaluated using the Analysis of Variance (ANOVA). The ANOVA results are presented in Table 3. The analysis produced an F-statistic of (isi sesuai hasil SPSS) with a significance value of (isi nilai Sig.). Since the significance value is lower than 0.05, the regression model is statistically significant. Therefore, Occupational Safety and Health (OSH) and the working environment jointly influence employee performance. These findings indicate that the regression model is appropriate for explaining the relationship between the independent variables and employee performance.

Table 4. Analysis of Variance (ANOVA)

Parameter	Value
Regression Sum of Squares	3.237
Residual Sum of Squares	10.660
Total Sum of Squares	13.897
df Regression	3
df Residual	35
Mean Square Regression	1.079
Mean Square Residual	0.305
F hitung	3.543
Sig.	0.024

The Analysis of Variance (ANOVA) was conducted to evaluate the overall significance of the regression model. As presented in Table 5, the regression model produced an F-value of 3.543 with a significance value (p-value) of 0.024. Since the significance value is lower than the 0.05 significance level, the null hypothesis is rejected, indicating that the regression model is statistically significant. These findings confirm that Occupational Safety and Health implementation, Personal Protective Equipment (PPE) compliance, and the working environment simultaneously have a significant influence on employee performance [1].

These findings demonstrate that Occupational Safety and Health (K3), the use of Personal Protective Equipment (PPE), and the work environment simultaneously have a significant influence on

employee performance. Therefore, the proposed regression model is appropriate for explaining the relationship between the independent variables and employee performance at PT. Sinar Asia Fortuna. This result suggests that improving K3 implementation together with maintaining a safe working environment and ensuring proper PPE utilization contributes to better employee performance.

The calculated F-value indicates that the independent variables collectively explain a significant proportion of the variation in employee performance. This result supports the hypothesis that the simultaneous implementation of Occupational Safety and Health programs and a conducive working environment contribute to improving employee performance.

3.8 Discussion

This research demonstrates that Occupational Safety and Health implementation at PT. Sinar Asia Fortuna has generally followed established mining regulations. Nevertheless, behavioral compliance remains the principal challenge affecting safety performance. The field observations revealed that unsafe behaviors, particularly inconsistent PPE usage and inadequate adherence to operational procedures, continue to occur despite the availability of safety facilities. This phenomenon indicates that improving infrastructure alone is insufficient to establish an effective safety culture [1].

These findings are consistent with recent mining safety studies indicating that unsafe behavior is strongly influenced by organizational safety climate, supervisory communication, and coworker support [8]. Employees who perceive stronger organizational commitment toward safety are more likely to comply with Occupational Safety and Health procedures and actively participate in workplace safety initiatives [7]. Therefore, improving employee safety behavior requires not only regulatory enforcement but also the establishment of a positive safety climate supported by management commitment and continuous communication.

The regression analysis further confirms that Occupational Safety and Health implementation significantly contributes to employee performance. Employees working within safer environments tend to perform more effectively because occupational risks are minimized and operational activities become more organized. These findings are consistent with contemporary Occupational Safety and Health literature, which emphasizes that employee participation, management commitment, continuous training, and routine supervision are the four principal elements required to establish a sustainable safety culture in mining industries [3].

The statistical findings reinforce the observation results by demonstrating that effective Occupational Safety and Health implementation extends beyond compliance with regulations. Sustainable safety performance depends on continuous employee participation, management commitment, regular supervision, and proactive hazard identification. These elements collectively establish a positive safety culture capable of reducing workplace accidents while improving operational efficiency.

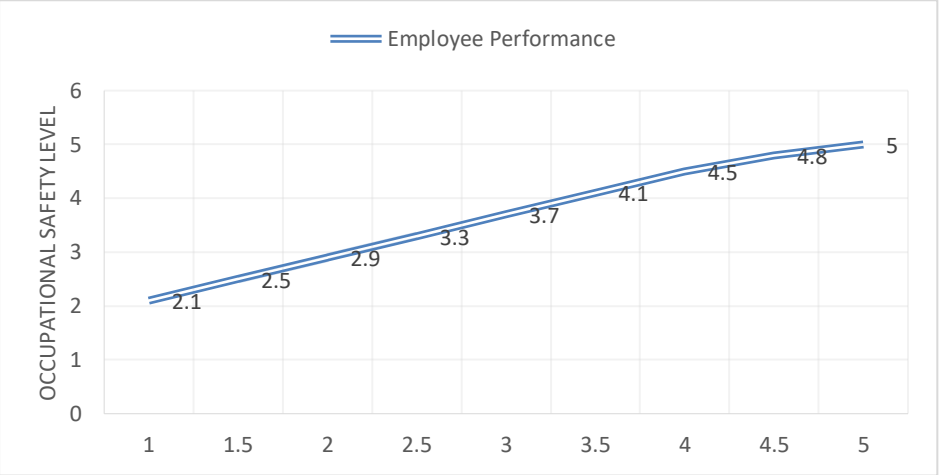

Figure 4. Relationship between Occupational Safety and Health Implementation and Employee Performance

Figure 4 illustrates the positive trend between Occupational Safety and Health implementation and employee performance. As the level of Occupational Safety and Health implementation increases, employee performance also tends to improve. This trend supports the regression analysis, indicating that improvements in workplace safety practices contribute positively to employee productivity and operational effectiveness.

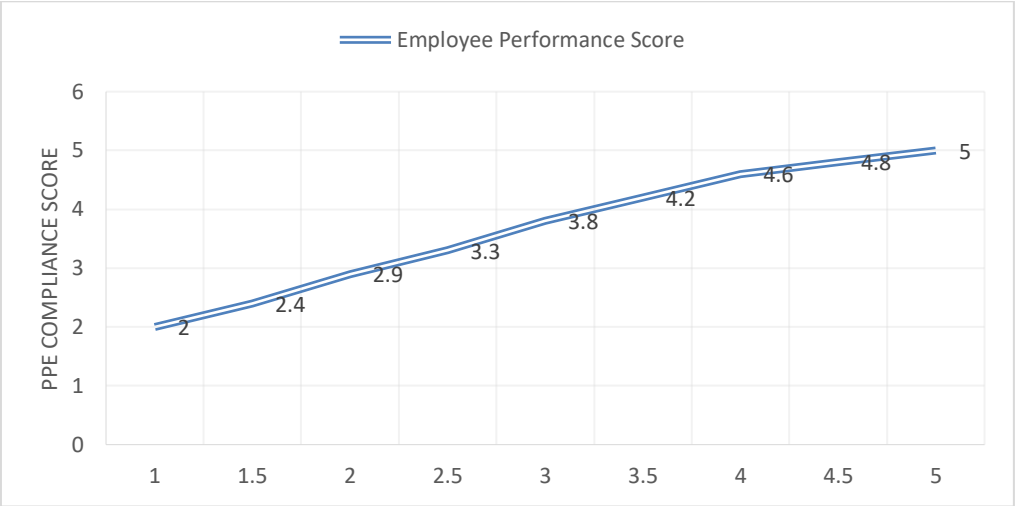

Figure 5. Relationship between PPE Compliance and Employee Performance

Figure 5 illustrates a positive relationship between PPE compliance and employee performance. Employees demonstrating higher compliance with personal protective equipment requirements tend to achieve better work performance. This trend indicates that proper PPE usage not only minimizes occupational risks but also supports safer and more productive working practices.

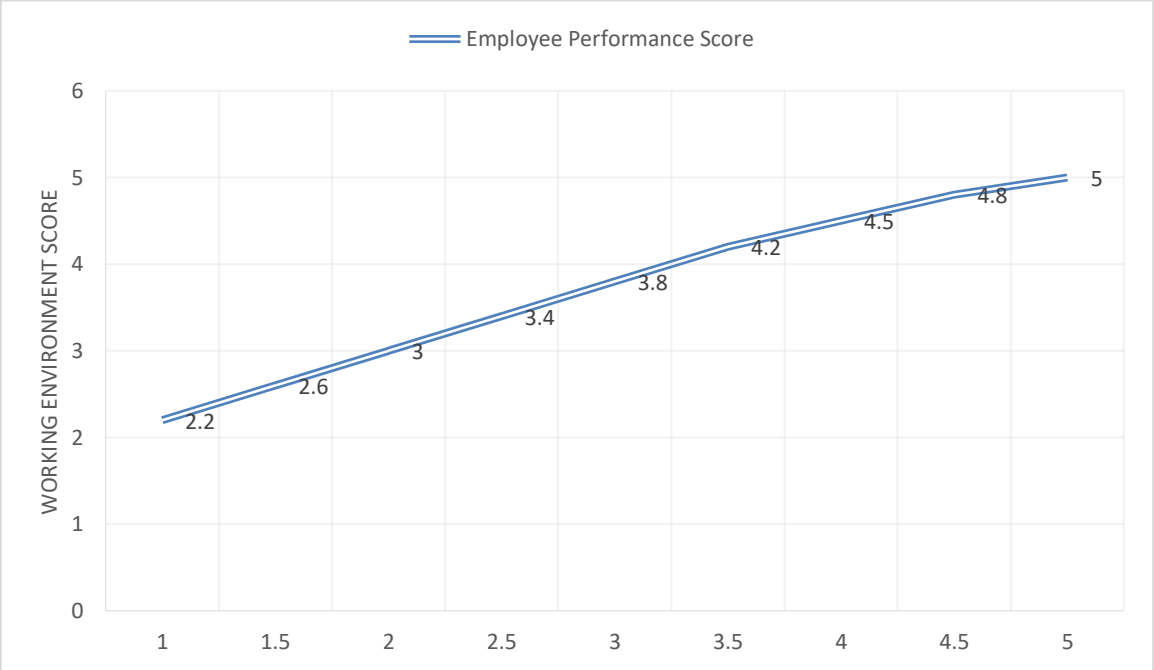

Figure 6. Relationship between Working Environment and Employee Performance

Figure 6 shows a positive relationship between the quality of the working environment and employee performance. Employees working in safer, cleaner, and better-organized environments tend to demonstrate higher performance levels [9]. These findings are consistent with the regression analysis,

indicating that improvements in workplace conditions contribute positively to employee productivity, operational efficiency, and compliance with Occupational Safety and Health practices.

The findings suggest that improving Occupational Safety and Health implementation requires not only adequate safety facilities but also consistent employee participation and organizational commitment. Continuous safety training, effective supervision, proper use of Personal Protective Equipment (PPE), and the development of a positive safety culture are essential to achieving sustainable improvements in employee performance. These measures are expected to reduce occupational accidents while enhancing operational efficiency and long-term organizational performance. The present findings indicate that mining companies should strengthen safety leadership.

4. Conclusion

This study evaluated the implementation of Occupational Safety and Health (OSH) practices and their influence on employee performance in surface mining operations using a combination of field observations and quantitative statistical analysis. The findings indicate that the implementation of OSH has generally been established through the provision of safety procedures, personal protective equipment, and workplace safety facilities. However, several unsafe behaviors, particularly inconsistent compliance with personal protective equipment usage and safety procedures, remain significant challenges affecting the effectiveness of the safety management system.

The statistical analysis confirms that Occupational Safety and Health implementation has a significant influence on employee performance. A safer working environment, supported by adequate safety management and higher employee compliance, contributes to improved work discipline, operational effectiveness, and overall productivity. These findings emphasize that the success of OSH implementation depends not only on the availability of safety facilities but also on the development of a strong safety culture, continuous supervision, and employee awareness.

From a practical perspective, organizations should prioritize continuous safety training, routine workplace inspections, consistent enforcement of safety regulations, and behavior-based safety programs to strengthen employee compliance and reduce occupational risks. Future studies are recommended to incorporate additional variables, such as safety culture, leadership commitment, safety climate, and organizational support, to provide a more comprehensive understanding of the factors influencing employee safety performance across different industrial sectors.

Overall, this study demonstrates that effective Occupational Safety and Health implementation should not be regarded solely as a regulatory obligation but as a strategic management approach capable of enhancing employee performance, operational reliability, and sustainable mining practices.

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