Majalah Bisnis & IPTEK
Vol. 19 No. 2, October 2026, 76 - 94
ISSN Online: 2502-1559. DOI: https://doi.org/10.55208/bistek
Published by P3M, STIE Pasundan, Bandung, Indonesia.

A Determinant Model of Employee Performance in the Coal Mining Industry of West Aceh: An Examination of Individual Factors

Murtaza. ZD[1], Mimin Suriadi[2], Rinda Pramadia[3], Fitrian Rizky[4]
[1,2,3] Sekolah Tinggi Ilmu Manajemen Indonesia Meulaboh, Indonesia
[4] Politeknik Kutaraja Banda Aceh, Indonesia
Email: murtaza.mm02@gmail.com[1], miminsuryadi@gmail.com[2], rindapramadiaba@gmail.com[3], fitrianrizky@poltekkutaraja.ac.id[4]

Abstract

This research examines the extent to which job satisfaction moderates the impact of Occupational Health and Safety and employee competency on performance outcomes in West Aceh's coal mining sector. Given the demanding, high-risk nature of mining activities, employee performance is crucial to ensuring both operational effectiveness and workplace safety. Optimal performance not only supports organizational productivity but also helps integrate safety standards and technical competencies, maintaining efficiency and resilience in the mining sector. The research population comprises all employees working in the coal mining industry in West Aceh. The study employs a quantitative design with hypothesis testing. The study used non-probability purposive sampling combined with convenience sampling because the researcher could access the most available respondents during the study period, meaning not all population members had an equal chance of selection. The study was conducted between May and June 2026. Primary data were gathered through a survey administered to employees. The analysis used PLS-SEM in SmartPLS 4 and comprised two phases: evaluating the measurement model for convergent and discriminant validity, and assessing the structural model to determine path coefficients, coefficients of determination, effect sizes, and predictive relevance. The analysis indicates that competency and job satisfaction significantly and positively predict employee performance, whereas OHS does not have a statistically significant impact. Subsequent moderation analysis shows that job satisfaction positively moderates the association between competency and performance, while negatively moderating the relationship between OHS and performance.

Keywords: *Competency, Employee Performance, Job Satisfaction, Mining, OHS*

Introduction

The coal mining industry in Indonesia is a strategic pillar of the national economy, contributing significantly to state revenue and to domestic and global energy security (Sharda, 2025). However, the high market demand, projected to continue increasing through 2030, requires companies to optimize productivity by managing high-quality human resources (Oyewole et al., 2024; Eleogu et al., 2023). Consequently, mining organizations' operational success depends on integrating technical skill development, strict adherence to occupational health and safety regulations, and adaptive motivational strategies (Yang et al., 2021).

Employee performance in this sector is a crucial asset that drives mining operations from exploration to marketing, making human resource management a decisive factor in corporate success amid high-risk work environments (Anggraini & Gustomo, 2025; Panda et al., 2025). High-performing employees not only support operational success and productivity but also help minimize workplace accidents and asset damage through technical expertise (Lawoyin et al., 2025).

Beyond its national economic contribution, this impact is also evident in West Aceh's coal mining industry. Employment in this region shows that employee performance is fundamental to sustaining company operations. The West Aceh District Government, through the Department of Manpower and Transmigration, has mandated that 70 percent of the workforce be recruited locally and 30 percent externally, ensuring that economic benefits are directly felt by surrounding communities while reducing the potential for social conflict. Public enthusiasm for employment in this sector is evident, as illustrated by the recruitment process at PT Cipta Kridatama (CK), which received more than 500 applications for only 40 Off-Highway Truck (OHT) driver positions with a 100-ton capacity, reflecting the high interest due to relatively high wages and job stability (Iskandar, 2026). Statistics from the West Aceh Central Bureau of Statistics indicate that the mining sector is a significant source of employment, particularly for working-age individuals with secondary and vocational education backgrounds. This reality emphasizes that workforce

performance in mining depends not only on technical and physical proficiencies but also on mental resilience in navigating high-risk operational environments. Consequently, effective performance management is essential to ensuring the mining industry's operational success in West Aceh (Badan Pusat Statistik, 2026).

Employee performance in coal mining companies is inseparable from the significant role of Occupational Health and Safety (OHS). OHS is a fundamental pillar for fostering a safe work environment and mitigating potential operational hazards (Bando, 2024). Implementing an integrated OHS management system reduces accident risk and fosters a stable professional environment, enabling personnel to develop their technical competencies without being hindered by safety concerns (Marhavilas et al., 2022; Bayram, 2019). Effective OHS requires not only the administrative provision of personal protective equipment but also leadership commitment to risk control and active worker participation to achieve superior operational standards (Vitrano & Micheli, 2024; Quansah et al., 2023). The effective implementation of OHS systems significantly influences employee performance outcomes.

Beyond OHS protocols, employee performance is strongly influenced by adequate professional competency. Mastery of specific technical skills and adaptability to advanced mining technologies have been empirically proven to reduce operational errors and enhance overall efficiency (MacMahon et al., 2024). Furthermore, continuous training builds competency and enables employees to navigate operational complexities in the field, sustaining productivity aligned with corporate targets (Bristol-Alagbariya et al., 2024). Based on Human Capital Theory, competency enhancement enables workers to identify hazards more effectively and implement corrective actions, ultimately mitigating risks in uncertain work environments. Consequently, highly competent employees tend to demonstrate stronger procedural compliance and greater technical efficiency in task execution, minimizing operational barriers and elevating overall safety performance standards (Özalçın & Çolakoğlu, 2025; Abikenova et al., 2023).

Job satisfaction critically moderates the relationship between OHS initiatives and improved employee performance. Job satisfaction tends to strengthen employees' commitment to safety compliance, thereby reducing high-risk behaviors and supporting the achievement of operational targets (Fiore et al., 2023). A sense of security and fulfillment enables employees to focus more effectively on technical tasks, free from safety-related distractions, thereby improving field efficiency and safety performance (Akano et al., 2024). Consequently, higher job satisfaction significantly moderates the positive impact of OHS on employee performance (Mixafenti et al., 2025; Zgair et al., 2023).

Moreover, job satisfaction also improves performance through its interaction with employee competency. Adequate competency fosters optimal performance, as employees feel more confident and capable of innovating to address technical challenges (Sari et al., 2022; Sabuhari et al., 2020). Structured and consistent training programs have been shown to enhance technical expertise, which in turn contributes to both employee performance and job satisfaction. Consequently, job satisfaction is a pivotal factor in sustaining employee performance in the coal mining sector (Chen et al., 2022; Kuranchie-Mensah & Amponsah-Tawiah, 2016).

Building on this background, this study examines the impact of OHS and employee competency on performance, while assessing the moderating role of job satisfaction among workers in the West Aceh coal mining industry.

Research Method

This research uses a quantitative, descriptive framework, employing survey instruments and parametric statistical techniques, including hypothesis testing, to examine the influence of OHS and employee competence on performance outcomes. The study also incorporates job satisfaction as a moderating variable to examine interactions among these factors, with a specific focus on employees in West Aceh's coal mining industry. The study population includes all individuals employed in the region's coal mining sector.

A non-probability sampling design was employed, integrating both purposive and convenience sampling methods. This approach was selected to enable the researcher to engage the most accessible participants during data collection, acknowledging that not all population members had an equal likelihood of inclusion. The research is planned to be conducted over two months, specifically from May to June 2026.

Primary data for this study were obtained via questionnaires distributed to the entire workforce within the coal mining sector of West Aceh. The study then used Partial Least Squares–Structural Equation Modeling (PLS-SEM). The implementation of this analytical framework proceeded in two key stages, specifically:

1) The PLS-SEM procedure encompasses a structured sequence of steps, beginning with the development of a conceptual model and concluding with the interpretation of the analytical outcomes. At this stage, both the structural and measurement models are specified by defining the relationships between constructs and their respective indicators, which represent latent variables. The measurement model is subsequently evaluated for convergent validity, as evidenced by factor loadings exceeding 0.70. Convergent validity is confirmed by Average Variance Extracted (AVE) values exceeding 0.50, while discriminant validity is evaluated via the Heterotrait–Monotrait ratio (HTMT), with values below 0.85 considered acceptable.

2) Structural model evaluation entails an analysis of path coefficients, the coefficient of determination, and effect sizes. The model's predictive relevance is also evaluated using Stone–Geisser's Q2 statistic, with values above zero indicating adequate predictive capability.

Results and Discussion

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Convergent validity was evaluated by examining outer loadings and AVE, as detailed in Table 1.

Table 1. Convergent Validity Test

Variable	Indicator	Outer Loading	Average Variance Extracted (AVE)	Conclusion
Occupational Health and Safety (OHS)	OHS1	0.706	0.615	Valid
	OHS2	0.796		
	OHS3	0.771		
	OHS4	0.809		
	OHS5	0.835		
Competency	COM1	0.830	0.674	Valid

Variable	Indicator	Outer Loading	Average Variance Extracted (AVE)	Conclusion
	COM2	0.808		
	COM3	0.810		
	COM4	0.846		
	COM5	0.812		
Employee Performance	EMP1	0.774	0.641	Valid
	EMP2	0.855		
	EMP3	0.819		
	EMP4	0.842		
	EMP5	0.701		
Job Satisfaction	JOS1	0.759	0.596	Valid
	JOS2	0.845		
	JOS3	0.729		
	JOS4	0.708		
	JOS5	0.811		

Table 1 indicates that all indicator outer loadings surpassed the 0.70 threshold. Additionally, the AVE values for each construct, specifically OHS, competency, employee performance, and job satisfaction, surpassed the 0.50 threshold. These findings confirm that the constructs meet the established criteria for convergent validity.

Discriminant Validity

To assess discriminant validity, this research used the cross-loading technique, which evaluates the degree to which each construct remains empirically independent within the model. The findings are shown in Table 2.

Table 2. Discriminant Validity Results Using the Cross-Loading Method

	OHS	Competency	Employee performance	Job satisfaction
OHS1	**0.706**	0.345	0.260	0.173
OHS2	**0.796**	0.500	0.319	0.198
OHS3	**0.771**	0.592	0.263	0.181
OHS4	**0.809**	0.557	0.286	0.187

	OHS	Competency	Employee performance	Job satisfaction
OHS5	**0.835**	0.516	0.270	0.146
COM1	0.529	**0.830**	0.285	0.108
COM2	0.543	**0.808**	0.269	0.112
COM3	0.525	**0.810**	0.254	0.145
COM4	0.483	**0.846**	0.308	0.231
COM5	0.555	**0.812**	0.320	0.144
EMP1	0.311	0.280	**0.774**	0.397
EMP2	0.283	0.234	**0.855**	0.401
EMP3	0.258	0.226	**0.819**	0.341
EMP4	0.272	0.299	**0.842**	0.363
EMP5	0.300	0.359	**0.701**	0.338
JOS1	0.322	0.453	0.348	**0.759**
JOS2	0.157	0.087	0.392	**0.845**
JOS3	0.139	-0.013	0.287	**0.729**
JOS4	0.169	0.019	0.238	**0.708**
JOS5	0.111	0.115	0.455	**0.811**

As shown in Table 2, the cross-loadings for each indicator were markedly higher for its designated construct than for alternative constructs, confirming that all model variables meet the established requirements for discriminant validity.

Reliability Test

The internal consistency of the indicators within each construct was assessed through reliability analysis, employing Cronbach's alpha and composite reliability as the primary metrics. The results of this assessment are presented in Table 3.

Table 3. Reliability Test

Variable	**Indicator**	**Cronbach Alpha**	**Composite Reliability**	**Conclusion**
OHS	OHS1	0.843	0.847	Reliable
	OHS2			
	OHS3			
	OHS4			
	OHS5			

Competency	COM1	0.879	0.883	Reliable
	COM2			
	COM3			
	COM4			
	COM5			
Employee performance	EMP1	0.858	0.858	Reliable
	EMP2			
	EMP3			
	EMP4			
	EMP5			
Job Satisfaction	JOS1	0.834	0.858	Reliable
	JOS2			
	JOS3			
	JOS4			
	JOS5			

Table 3 illustrates that all variables surpassed the 0.70 threshold for both Cronbach's alpha and composite reliability, confirming the internal consistency of the indicators and constructs assessed in this research.

Structural Model Evaluation

Coefficients of determination and effect sizes facilitate the evaluation of the structural model, whereas the Stone–Geisser statistic indicates predictive relevance. Table 4 provides an overview of these initial analytical procedures.

Table 4. Determination Coefficient (R2)

Variable	**R-square**	**R-square adjusted**
Employee Performance	0.337	0.322

As shown in Table 4, the model achieves an R^2 of 0.337 for employee performance. This suggests the independent variables account for 33.7% of the observed variance, leaving 66.3% unexplained by factors outside the proposed framework.

The subsequent structural model evaluation employs effect size (f^2), with the results reported in Table 5.

Table 5. Effect Size (f2)

Variable	Employee Performance
OHS	0.017
Competency	0.046
Job Satisfaction	0.184
Job Satisfaction x OHS	0.024
Job Satisfaction x Competency	0.051

The f^2 effect sizes in Table 5 show each construct's relative contribution. The analysis indicated that job satisfaction had the most significant impact on employee performance, with an effect size of 0.184, classified as large. Conversely, OHS showed a smaller effect size of 0.017. These findings establish job satisfaction as the principal determinant of employee performance.

To augment the effect size analysis, the model's predictive relevance was determined using the Stone–Geisser Q^2 statistic, as documented in Table 6.

Table 6. Q2 Analysis

Variable	Q^2predict	RMSE	MAE
Employee Performance	0.284	0.860	0.640

Table 6 reports the results of the predictive relevance test (Q^2), indicating that employee performance attained a Q^2 value of 0.284. This indicates that Q^2 is positively predictive and falls within the good category, thereby confirming the model's predictive relevance. The model shows a moderate error rate, with an RMSE of 0.860 and an MAE of 0.640, consistent with the robust Q^2 results.

Result of Hypothesis Test

To examine the study's hypotheses, PLS-SEM was conducted using SmartPLS 4. Bootstrapping procedures were implemented to establish empirical sampling distributions and to evaluate the significance of path coefficients. Statistical significance for the hypotheses was assessed using path coefficients, t-statistics, and p-values, with a threshold of $p < 0.05$. The results of the hypothesis testing are presented in Table 7.

Table 7. Hypothesis Testing

Hypothesis	β	t-statistic	*P-Value*	Result
OHS → EMP	0.140	1.672	0.095	Not Significant
COM → EMP	0.235	2.934	0.003	Significant
JOS → EMP	0.363	5.820	0.000	Significant
OHS x JOS → EMP	-0.150	2.015	0.044	Significant
COM x JOS → EMP	0.236	2.699	0.007	Significant

Table 7 provides the basis for interpreting the hypothesis testing results, and the findings of these analyses are detailed in Figure 1.

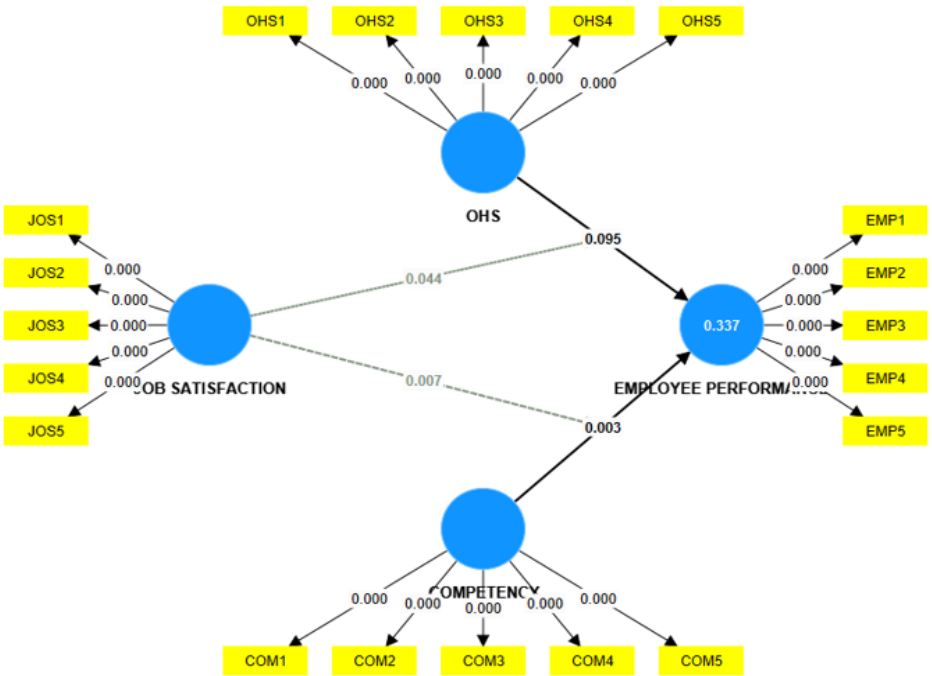


Figure 1. Path Diagram of PLS-SEM for Hypothesis Testing

To Figure 1 illustrates the beta coefficients from the model used for hypothesis testing, whereas Table 7 provides a comprehensive summary of the test results. Based on the hypothesis test, the OHS variable had no statistically significant impact (p=0.095). Conversely, both competency (p=0.003) and job satisfaction (p<0.000) demonstrated significant positive effects on employee performance. Furthermore, job satisfaction significantly moderated the relationships between OHS (p=0.044), competency (p=0.007), and employee performance.

Empirical analysis revealed that Occupational Health and Safety variables exerted no statistically significant effect on employee performance within the coal mining industry in West Aceh (p-value = 0.095; > 0.05). This finding suggests that OHS implementation in mining work environments is perceived more as a minimum standard companies must meet to ensure workplace safety, rather than a direct driver of productivity or employee performance. While OHS remains a fundamental operational requirement, companies should integrate safety policies with broader managerial strategies to strengthen motivation and job satisfaction, thereby generating a more tangible impact on employee performance.

Statistical analysis indicates that competency has a significant positive influence on employee performance in the coal mining industry in West Aceh (p-value = 0.003; < 0.05). This finding suggests that competency, encompassing skills, knowledge, and individual abilities, is a critical determinant of performance enhancement. Employees with higher competency levels can complete tasks more efficiently, adapt to workplace challenges, and contribute meaningfully to organizational productivity. From a managerial perspective, corporate investment in competency development through training, education, and capacity building will directly enhance performance.

The job satisfaction variable was found to have a positive and significant effect on employee performance in the coal mining industry of West Aceh, with a probability value of 0.000 (<0.05). This result highlights job satisfaction as a key factor that strengthens employee engagement, loyalty, and willingness to exert extra effort in fulfilling responsibilities. Job

satisfaction is positively correlated with increased intrinsic motivation, which in turn drives improvements in both productivity and performance quality. Consequently, these results underscore the imperative for organizations to implement comprehensive policies that foster employee well-being, facilitate career progression, optimize reward structures, and cultivate a supportive work environment.

Within the West Aceh coal mining industry, empirical analysis indicates that job satisfaction significantly moderates the negative impact of OHS on employee performance (p-value = 0.044; < 0.05). These findings suggest that, contrary to prevailing evidence that job satisfaction generally strengthens the positive association between OHS and performance, this study found a statistically significant inverse moderating effect in this context. This can be explained by the possibility that when job satisfaction is high, employees may become overly comfortable with existing work conditions. Consequently, stringent OHS procedures may no longer be perceived as productivity drivers, but rather as bureaucratic burdens that impede operational efficiency. However, in the high-risk context of the coal mining sector, safety remains a non-negotiable priority. This negative moderation reflects potential misalignments between OHS policies and actual worker needs or resource constraints, rather than an inherent flaw in safety standards. From a managerial perspective, these findings underscore the need to re-evaluate OHS policies not to compromise safety compliance, but to align safety protocols with job satisfaction factors, ensuring safety controls enhance, rather than hinder, employee productivity.

In the coal mining sector in West Aceh, job satisfaction significantly moderates the relationship between competency and employee performance (p-value = 0.007; < 0.05). These findings indicate that job satisfaction reinforces this association, suggesting that the performance contributions of competent employees are enhanced when they report higher levels of job satisfaction. This condition reflects the synergy between technical factors (competence) and psychological factors (job satisfaction), in which employees' skills and knowledge are more effectively applied when supported by a satisfying work environment. From a managerial

standpoint, this finding underscores the need to integrate competency development strategies with initiatives that enhance job satisfaction, such as continuous training, reward systems, and supportive work facilities. Consequently, aligning professional competence with job satisfaction is a critical determinant of productivity and employee performance in the mining sector, requiring a synthesis of specialized technical expertise and psychological resilience.

The PLS-SEM model yielded an R2 value of 0.337, indicating that the independent variables explain approximately 33.7% of the variance in the dependent variable. The remaining 66.3% is presumably attributed to external factors not captured within the present framework. This moderate R2 value implies that, while the model provides some explanatory power, additional determinants beyond the scope of this research likely contribute substantially to employee performance.

Conclusion

The findings indicate that, in the West Aceh coal mining sector, competency and job satisfaction significantly and positively influence employee performance. Conversely, Occupational Health and Safety measures were found to have no statistically significant direct effect, suggesting that these protocols are perceived primarily as regulatory requirements rather than as drivers of productivity.

These findings highlight job satisfaction as the strongest determinant of employee performance, exerting the greatest influence among the variables examined. Moreover, the moderation analysis shows that job satisfaction negatively moderates the relationship between OHS and performance while strengthening competency's influence on performance outcomes. This highlights a complex interplay between technical and psychological factors, where competency development yields optimal results when accompanied by high job satisfaction. In contrast, OHS policies may inadvertently reduce effectiveness if they do not align with employee needs and perceptions.

This study substantiates that competency and job satisfaction are

pivotal elements in enhancing employee performance in the mining sector, which demands both technical expertise and psychological resilience. Managerial implications emphasize the importance of integrating competency development programs with policies that foster job satisfaction, including training, reward systems, and supportive work environments. Conversely, Occupational Health and Safety policies must be re-evaluated to ensure they go beyond basic compliance requirements, fostering employee motivation and organizational productivity.

The coefficient of determination (R2 = 0.337) indicates that the analyzed variables account for 33.7% of the variance in employee performance, with 66.3% attributable to unobserved factors. This limitation calls for future research that broadens the scope by incorporating variables such as leadership quality, organizational culture, workload, and stress management. Furthermore, adopting longitudinal designs is recommended to capture temporal dynamics, offering a more granular understanding of performance determinants in high-risk contexts such as the coal mining industry.

Acknowledgment

The author sincerely appreciates Sekolah Tinggi Ilmu Manajemen Indonesia (STIMI) Meulaboh for the academic support and research facilities provided. Furthermore, gratitude is extended to the Directorate of Research and Community Service, Ministry of Higher Education, Science, and Technology of the Republic of Indonesia, for the 2026 research grant that enabled the completion of this study. Both institutions were instrumental to the success of this research, particularly through financial assistance and enhanced academic capacity.

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Conflicts Of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Use Of Artificial Intelligence (AI)

The authors transparently disclose the use of AI Tool exclusively for the purpose of linguistic editing and grammatical refinement of the original draft. The authors

maintain full responsibility for the manuscript's substantive content, data integrity, andfinal scientific conclusions.sion to publish the results.


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