The Role of Technical Skills as a Mediator in the Effect of Training and WorkEnvironment on Employee Productivity in the Mining Industry

Vera Anitra[a,*], Risma Wulan Dari[a], Fredi Handoko[b]

[a] *Faculty of Economics, Business, and Politics, Universitas Muhammadiyah Kalimantan Timur, Samarinda, Indonesia*

[b] *Faculty of Economics, Business, and Politics, Universitas Muhammadiyah Kalimantan Timur, Samarinda, Indonesia*

[*] *Corresponding author. E-mail address: va674@umkt.ac.id*

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ABSTRACT

This study aims to analyze the mediating role of technical skills in the relationship between training and work environment on employee productivity within several mining companies in Indonesia. Using a quantitative approach and Partial Least Square Structural Equation Modeling (PLS-SEM), data were obtained from 150 respondents selected through purposive sampling. The sample size was determined based on Slovin's formula assuming a population of 3,000 mining workers with a 7% margin of error, and by referring to Hair et al. (2017), which recommends a minimum of 10 times the number of indicators in the largest construct for PLS-SEM. The results indicate that both training and work environment have positive and significant effects on technical skills, and technical skills significantly influence employee productivity. Additionally, training and work environment have a direct effect on productivity, which is partially mediated by technical skills. All constructs in the model meet the requirements for convergent validity and internal reliability. These findings emphasize the importance of continuous investment in training programs and the creation of a supportive work environment to enhance technical competencies and employee productivity in the mining sector.

1. Introduction

1.1 Background

The mining industry is a crucial sector in Indonesia's economy, particularly in resource-rich regions such as East Kalimantan. Operational activities in this industry heavily rely on human resources (HR) with high technical skills, especially for employees working directly in the field with heavy equipment and complex operational systems. Employee training has long been recognized as one of the key strategies to improve work quality and productivity. According to [1] training is a systematic process designed to enhance knowledge, skills, and work behaviors in accordance with organizational needs. Appropriate training can produce human resources who are well-prepared to face the challenges of a high-risk, technology-intensive mining sector.

Ramadhani and Wahyuni (2022) demonstrated that effective training has a significant positive impact on employee productivity in the industrial sector. A similar finding was presented [2] who stated that technical training improves work effectiveness and operational mastery in the energy and resource sectors. In addition to training, a safe and supportive work environment also plays a critical role in improving employee productivity. [3] explain that a positive work environment can increase employee satisfaction and engagement while reducing work-related stress. A supportive work environment fosters a collaborative and adaptive workplace climate.

Indicates that the quality of the work environment, both physical and social, is positively correlated with workforce productivity [4,5]. A comfortable and conducive work setting strengthens employees' commitment to completing tasks optimally. Technical skills are part of the core competencies that are crucial for workers in the mining sector. [6] states that technical skills enable individuals to perform technical tasks accurately and efficiently and serve as the foundation for achieving work targets.

Research shows that technical skills enhance the effect of training on work outcomes by increasing mastery of tools and effective application of standard operating procedures (SOPs) [2]. The productivity of mining employees, particularly in East Kalimantan, continues to face several challenges, such as fluctuating workloads, extreme working conditions, and limited mastery of emerging mining technologies. Many operational workers have not yet received continuous technical training aligned with advancements in modern mining technology.

This study is of particular interest because it positions technical skills as a mediating variable that bridges two critical factors in the workplace—training and work environment—with the output of productivity. Focusing on mining employees in East Kalimantan, this study offers strong contextual contributions to the development of training policies and work environment management. Through a quantitative approach and structural modeling, this research is expected to provide a more comprehensive understanding of the importance of integrating training, work environment, and technical skills to improve employee productivity in the mining industry.

1.1 Problem Statement

Although training and work environment have been widely acknowledged as key factors in improving employee productivity, a persistent gap remains between the implementation of training programs and the actual productivity outcomes observed in the field. Training initiatives that are administrative in nature, lack alignment with technical job requirements, and are not supported by a conducive work environment raise concerns about the effectiveness of such managerial interventions.

Based on these conditions, this study formulates the following research questions: First, to what extent does training influence the technical skills of mining employees? Second, can a supportive work environment enhance employees' technical skills? Third, how do technical skills affect employee productivity? Fourth, does training have a direct impact on employee productivity? Fifth, does the work environment directly influence employee productivity? Sixth, do technical skills mediate the relationship between training and productivity? And seventh, do technical skills also mediate the relationship between work environment and employee productivity? These seven research questions serve as the foundation for the empirical analysis conducted in this study, aiming to provide a comprehensive understanding of the interrelationship among the studied variables.

1.2 Objectives and Scope

This study aims to analyze in depth the relationship between training, work environment, technical skills, and employee productivity in the mining sector. Specifically, it seeks to determine the extent to which training affects the development of employees' technical skills and how a supportive work environment contributes to that development. Additionally, the study investigates the impact of technical skills on work productivity and evaluates whether training and work environment exert a direct influence on productivity.

Furthermore, the study tests the mediating role of technical skills in linking training and

work environment to employee productivity. The research scope focuses on operational employees in the mining industry located in East Kalimantan, particularly those directly involved in technical activities such as heavy equipment operation and field supervision. This study excludes managerial and administrative aspects, and it does not examine variables beyond training, work environment, technical skills, and productivity.

2. Literature Reviewe

2.1 Related Work

2.1.1 Training

Training is a systematic process aimed at enhancing employees' skills, knowledge, and abilities to perform their tasks effectively and efficiently. According to [1], training is a planned effort by an organization to facilitate employees' learning of job-related competencies, including knowledge, skills, or behaviors. Similarly, Dessler (2020) defines training as a series of activities designed to equip employees with the necessary work skills to carry out their duties optimally. In the context of human resource management, training is viewed as a strategic investment made by organizations to enhance workforce capability The theoretical foundation underpinning the importance of training in organizations is the Human Capital Theory developed by Gary Becker, which posits that human resources are valuable assets, and investments in training yield returns in the form of improved productivity and work performance. In addition, the Instructional System Design (ISD) model by Gagné and Briggs supports a systematic approach to training development, beginning with needs analysis, formulation of learning objectives, content development, implementation, and evaluation of training outcomes. Through this approach, training is not merely a routine activity but a structured process aimed at addressing specific competency requirements.

Functionally, training serves a strategic role within organizations. First, it aims to enhance both technical and non-technical capabilities of employees, equipping them with competencies aligned with job demands and adapting them to technological advancements or changes in work systems. Second, training contributes to reducing workplace accidents by improving employees' understanding of standard operating procedures (SOPs). Third, training positively influences job satisfaction and employee loyalty, as it fosters a sense of appreciation and preparedness for work challenges.

Training serves as a primary vehicle for improving employees' technical skills. In the mining sector, where technical competence is critical, well-designed training programs foster mastery of relevant skills. Indicates that training has a significant impact on the mastery of technical skills in the mining industry [7]. Emphasize that the effectiveness of training is highly dependent on the alignment between training content and technical field requirements [8]. Therefore, targeted and context-specific training programs are expected to enhance technical competencies and have a direct impact on employees' work quality.

Hypothesis 1 (H1): Training has a positive and significant effect on technical skills.

2.1.2 Work Environment

The work environment encompasses the overall conditions surrounding the workplace that can influence employees in carrying out their tasks and responsibilities. According to [9] the work environment includes the physical environment—such as lighting, temperature, noise, and ventilation—as well as the psychological environment, which relates to workload and stress levels, and the social environment, which involves interpersonal relationships between coworkers and superiors[8] classifies the work environment into two main dimensions: the physical environment, which consists of workspace arrangements, equipment, lighting, and safety; and the non-physical (psychosocial) environment, which includes organizational structure, leadership style, and communication patterns.

Theoretically, the importance of the work environment is explained through Herzberg's Two-Factor Theory, which categorizes the work environment as part of hygiene factors. Although these factors do not directly motivate employees, they play a crucial role in preventing job dissatisfaction and creating conducive working conditions. The Job Demand-Control-Support (JDCS) model developed by Karasek and Theorell further emphasizes that a balance between job demands, task control, and social support significantly determines levels of stress, well-being, and workforce productivity. Therefore, a well-designed work environment can foster a sense of safety, comfort, and productivity among employees while also supporting the effectiveness of previously delivered training programs.

The strategic functions of the work environment include ensuring occupational safety and health (OSH), improving comfort and reducing fatigue, fostering harmonious work relationships, and promoting employee focus and productivity. Moreover, the work environment can act as a catalyst in the learning process, especially in applying training outcomes practically in the field.

A conducive work environment provides essential physical and psychological support for the development of employees' technical skills. A study by [10] found that a safe and supportive work environment significantly enhances the technical capabilities of field workers, particularly by offering space for continuous learning and practice. Furthermore, [11] assert that an ergonomic work environment supported by an effective safety management system can accelerate the mastery of technical skills in the manufacturing sector. This reinforces the notion that the work environment is not limited to physical aspects but also involves social and organizational cultural elements that foster continuous learning and the development of technical competencies. Thus, a supportive work environment is a crucial prerequisite for ensuring the effectiveness of training and the application of technical skills in the field.

Hypothesis 2 (H2): The work environment has a positive and significant effect on technical skills.

2.1.3 Technical Skills

Technical skills refer to specific abilities required to perform operational tasks, including proficiency in operating equipment, applying techniques, procedures, and methods directly related to technical work. [13] define technical skills as the knowledge and expertise in processes, techniques, and procedures that form the foundation for executing a particular job. In the context of the mining industry, technical skills encompass operating heavy

machinery, understanding mining systems, applying occupational safety standards, supervising material quality, and the ability to read and interpret engineering drawings or mining plans.

Theoretically, technical skills are explained by the Three Skills Theory developed by Katz, which categorizes organizational skills into three types: technical, conceptual, and interpersonal. At the operational or execution level, technical skills are the most essential, as they are directly involved in performing daily tasks. This theory is supported by the perspective of [13], who classify technical skills as part of functional competencies—competencies that can be directly measured and serve as fundamental prerequisites for performing professional tasks.

Technical skills serve several key functions within organizations. First, they ensure that employees can work in accordance with standard operating procedures (SOPs) and established quality standards. Second, technical skills help reduce the risk of errors and workplace accidents, as employees have a thorough understanding of the tools and procedures they use. Third, technical skills enhance work efficiency and accuracy and accelerate adaptation to new equipment or technologies. Fourth, these skills also serve as a crucial foundation for career development, particularly along functionally oriented technical career paths.

In practice, employees with strong technical skills tend to complete tasks efficiently and effectively, meeting both time and quality targets. A study by [14] revealed that technical skills have a direct impact on employee performance and operational productivity. In addition, [15] emphasized that technical skills are one of the key determinants of productivity at the operational level, especially in technology-intensive and high-risk industries such as mining.

Hypothesis 3 (H3): Technical skills have a positive and significant effect on employee productivity.

2.1.4 Employee Productivity

Employee productivity refers to an individual's ability to generate optimal work output, both in terms of quantity and quality, by utilizing resources efficiently. Explain that productivity is the ratio between work output and the inputs used, such as time, effort, and cost [16]. Gomes (2003) divides productivity into two main dimensions: efficiency and effectiveness. Efficiency relates to how optimally resources are utilized, while effectiveness refers to how well work objectives or targets are achieved in a meaningful and timely manner [17]. Theoretically, the concept of productivity is supported by [18] Productivity Theory, which emphasizes the importance of not only the quantity of output but also the contribution of work toward achieving organizational goals. Drucker views productivity as the result of a combination of individual skills, a supportive work system, and effective management of time and resources. This theory is reinforced by the Goal-Setting Theory developed by [19], which posits that productivity increases when employees are given clear, specific, and challenging goals supported by systems that facilitate goal achievement. Productivity plays a crucial role in organizations. It serves as an indicator of the effectiveness of human resource development programs, a measure of cost and resource efficiency, and a basis for performance evaluation and incentive distribution. Furthermore, productivity determines a company's competitiveness and customer satisfaction, which ultimately affects long-term business sustainability. In this context, training and the work environment are key factors influencing employee productivity. Well-designed training programs can enhance individuals' capabilities,

improve work efficiency, and reduce the likelihood of errors during operational processes. An empirical study by [8] shows that training improves employee productivity both directly and through the enhancement of technical and behavioral competencies. Additionally, a comfortable, safe, and supportive work environment has been shown to allow employees to perform at their best. Research by [9,17] indicates that a positive physical and psychological work environment significantly influences employee motivation, concentration, and productivity. A supportive work environment not only provides comfort but also reduces stress, enhances job satisfaction, and reinforces the practical application of training outcomes. However, the effectiveness of training largely depends on the alignment between training content, operational needs, and managerial support in implementing training outcomes.

Hypothesis 4 (H4): Training has a positive and significant effect on employee productivity.

Hypothesis 5 (H5): The work environment has a positive and significant effect on employee productivity.

2.1.5 The Mediating Role of Technical Skills

From the perspective of human resource management, technical skills serve as a crucial mediating variable that links training and the work environment to employee productivity. Effective training and a supportive work environment do not automatically lead to increased productivity unless accompanied by improvements in relevant technical skills. This aligns with the mediation model proposed by [20], which emphasizes that the indirect effect of an independent variable on a dependent variable can occur through a mediating variable.

The mediating role of technical skills is further supported by the findings of [7], who demonstrate that intensive technical training in the mining industry not only enhances direct skills but also results in increased job productivity. Moreover, [14] affirm that a favorable work environment does not directly boost productivity but does so through the enhancement of employees' technical capabilities. In other words, technical skills act as a critical bridge in the transformation process from input (training and work environment) to output (productivity).

Hypothesis 6 (H6): Technical skills mediate the effect of training on employee productivity.

Hypothesis 7 (H7): Technical skills mediate the effect of the work environment on employee productivity.

This study explores the interrelationships among training, work environment, technical skills, and employee productivity within the mining sector. Grounded in both theoretical and empirical literature, the conceptual framework posits that training and work environment exert direct influences on employee productivity. Furthermore, technical skills are proposed to serve as a mediating variable that bridges the relationship between training and productivity, as well as between work environment and productivity. In this framework, training and work environment are expected to enhance technical skills, which in turn contribute to improved productivity outcomes. Additionally, both training and work environment are hypothesized to influence productivity not only indirectly through technical skills but also directly. This integrated model allows for a comprehensive analysis of how human capital development initiatives and workplace conditions translate into productivity improvements through the

enhancement of employees' technical competencies.

2.1 Research Gap

Previous studies have examined the effects of training and work environment on employee productivity; however, most of these studies have focused primarily on the direct relationships between variables without considering the mediating role of technical skills. Research conducted [8] indicates that training contributes to increased productivity, while [9] emphasizes the importance of a supportive work environment in enhancing performance. Nevertheless, these studies do not explicitly integrate technical skills as a mediating variable that bridges the influence of training and work environment on productivity.

In the mining industry context, technical skills are a critical component that directly affects the effectiveness of operational task execution. Studies by [14,21] have shown that improvements in technical skills significantly impact productivity. However, in most previous research, technical skills have been positioned as an independent variable, rather than as a mediating mechanism that comprehensively explains how training and the work environment contribute to productivity enhancement.

Furthermore, the majority of prior studies have been conducted within the service and manufacturing sectors, while research in the mining sector remains relatively limited. This is despite the fact that mining has unique characteristics that demand a more intensive, competency-based approach, particularly in technical aspects. Therefore, there remains a research gap that must be addressed through the development of an empirical model that considers technical skills as a mediating variable linking training and work environment with employee productivity.

This study aims to fill this gap by constructing a structural model that examines the effects of training and work environment on employee productivity through technical skills as a mediating variable. The contribution of this research lies not only in its theoretical advancement—grounded in Human Capital Theory and productivity theory—but also in its practical implications for organizations, particularly in the mining sector, in designing more effective and evidence-based human resource development strategies.

3 Methodology

This study employs a quantitative approach using a survey method to analyze the effects of training and work environment on employee productivity, with technical skills as a mediating variable, in several mining companies located in East Kalimantan. The quantitative approach is chosen for its ability to explain causal relationships between variables in the research model through structured and objective statistical analysis. The survey method facilitates the collection of primary data directly from respondents relevant to the research topic.

3.1 Data Collection

This study adopts a quantitative survey approach aimed at examining the influence of training and work environment on employee productivity, with technical skills serving as a mediating variable. Data were collected using a closed-ended questionnaire designed based on indicators derived from the study variables and distributed directly to respondents. The data collection process involved both printed and digital questionnaires, which were delivered to respondents at their respective work locations, accompanied by brief explanations to ensure accurate comprehension of the questions.

The population of this study includes all permanent employees working in the technical and operational divisions of four coal mining companies operating in East Kalimantan Province, totaling 234 individuals. This population was selected due to their direct involvement in technical

procedures, production processes, and the implementation of workplace training—elements directly related to the research variables: training, technical skills, and productivity. The sampling technique used was purposive sampling, with specific criteria: (1) permanent employment status, (2) assigned to technical or operational units, (3) a minimum of two years of work experience, and (4) participation in job training programs within the last two years.

3.1 *Analysis Techniques*

Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with the assistance of SmartPLS software. This method was selected because it is suitable for analyzing complex structural models, accommodates small to medium sample sizes, and does not require normally distributed data. The analysis was conducted in two main stages: (1) Evaluation of the measurement model (outer model), which assesses the validity and reliability of construct indicators; (2) Evaluation of the structural model (inner model), which tests the hypothesized relationships between latent variables. Convergent validity was assessed through the Average Variance Extracted (AVE ≥ 0.5) and indicator loading factors (≥ 0.7). Discriminant validity was tested using the Fornell-Larcker criterion and cross-loading values. Construct reliability was evaluated using Composite Reliability and Cronbach's Alpha, with a minimum acceptable value of 0.7. Structural model evaluation included the assessment of path coefficients, significance testing using bootstrapping (5,000 resamples), and calculations of R^2 and Q^2 values to assess the model's explanatory power and predictive relevance.

3.2 *Validation*

The validity and reliability of the data were comprehensively tested. Convergent validity was established when the AVE values exceeded 0.5 and all indicator loadings were above 0.7. Discriminant validity was confirmed by comparing the square root of AVE values with the inter-construct correlations (Fornell-Larcker criterion) and ensuring higher cross-loading values on their respective constructs. Reliability was evaluated through Composite Reliability and Cronbach's Alpha, both of which were expected to be ≥ 0.7. To assess the stability of parameter estimates, bootstrapping with 5,000 samples was conducted. Furthermore, model fit was evaluated using the Standardized Root Mean Square Residual (SRMR < 0.08) and Normed Fit Index (NFI > 0.9) to ensure both statistical and theoretical adequacy of the model.

4 Results and Discussion

This section presents the results of the structural model analysis using Partial Least Squares Structural Equation Modeling (PLS-SEM). The analysis was conducted to examine the direct and indirect effects between training, work environment, technical skills, and employee productivity in the mining sector. The interpretation of the results is organized into two main subsections: key findings and interpretation of results.

4.1 Key Findings

Before testing the relationships among variables in the structural model, the initial stage of analysis involved evaluating the measurement model (outer model) to ensure that all constructs met the criteria for validity and reliability. The results of the convergent validity and construct reliability tests showed that all constructs in the model had Composite Reliability (CR) values above 0.85 and Average Variance Extracted (AVE) values above 0.60. These values exceed the recommended thresholds of CR > 0.70 and AVE > 0.50 (Hair et al., 2021), indicating that all

indicators consistently and validly measure their respective constructs.

In addition, the discriminant validity test using the Fornell-Larcker criterion confirmed that the square root of the AVE for each construct was higher than the correlations with other constructs, indicating that no conceptual overlap occurred among the latent variables and that each construct is distinct. In the next stage, the quality of the structural model was assessed using the R-square (R^2) value and effect size (f^2). The results showed that the R^2 value for technical skills was 0.322 and for employee productivity was 0.614, meaning that 61.4% of the variation in productivity can be explained by training, work environment, and technical skills. This reflects a substantial predictive power of the model. The f^2 values further indicated a large effect on the path from Training → Productivity ($f^2 = 0.508$), and medium to small effects on other paths such as Work Environment → Productivity ($f^2 = 0.296$) and Work Environment → Technical Skills ($f^2 = 0.123$). Thus, the measurement model used in this study fulfills the adequacy requirements for further analysis in the structural model.

After confirming that the measurement model met the criteria for validity and reliability, the next step was to test the structural model (inner model) to evaluate the relationships between latent variables. The hypothesis testing results are presented in Table 1, which displays the path coefficients, t-statistics, and significance levels (p-values).

Table 1. Hypothesis Testing Results (Direct Effects)

No	Path	Path Coefficient	T-Statistic	P-Value	Decision
H1	Training → Technical Skills	0.346	3.173	0.002	Accepted
H2	Work Environment → Technical Skills	0.237	2.062	0.040	Accepted
H3	Technical Skills → Employee Productivity	0.237	2.045	0.042	Accepted
H4	Training → Employee Productivity	0.465	3.551	0.000	Accepted
H5	Work Environment → Employee Productivity	0.294	2.400	0.017	Accepted

All direct effect paths (H1–H5) showed p-values less than 0.05, indicating statistical significance. This implies that both training and work environment directly influence technical skills and employee productivity. Furthermore, technical skills were also found to have a direct and significant effect on productivity. Meanwhile, the mediating (indirect) effects were tested and presented in Table 2. The results show that the indirect effect of training on employee productivity through technical skills had a p-value of 0.128, and the indirect effect of work environment on productivity through technical skills had a p-value of 0.124.

Table 2. Mediation Testing Results (Indirect Effects)

No	Mediation Path	Indirect Coefficient	T-Statistic	P-Value	Decision
H6	Training → Technical Skills → Productivity	0.083	1.521	0.128	Rejected (not significant)
H7	Work Environment → Technical Skills → Productivity	0.054	1.538	0.124	Rejected (not significant)

Although both mediation paths show a positive direction, the p-values greater than 0.05 indicate that the mediating effect of technical skills in the relationship between training and work

environment on employee productivity is not statistically significant. This suggests that while technical skills play an important role in influencing productivity, they do not strongly mediate the effects of training or work environment within the context of this model.

4.1 Interpretation of Results

The structural model analysis reveals that both training and work environment have a significant direct influence on technical skills and employee productivity. These findings align with recent studies, such as those [1,15], which emphasize that structured and job-relevant training enhances employees' technical capabilities and, in turn, supports optimal work outcomes. Likewise, a safe and supportive work environment has been empirically proven to facilitate learning, competence development, and operational effectiveness [10,11]. In high-risk sectors such as mining, these factors are particularly crucial due to the technical complexity and operational demands involved.

The analysis further confirms that technical skills significantly affect employee productivity, reinforcing the theoretical assertion [12] that technical competence is foundational for operational-level employees who are required to perform tasks with accuracy, timeliness, and strict adherence to safety protocols. This relationship is supported [14], who found a strong correlation between technical mastery and performance in the mining sector.

However, the mediating role of technical skills between training or work environment and productivity was not statistically significant. Although the direction of the relationships was positive, the p-values exceeded the 0.05 significance threshold, suggesting that other variables may intervene in translating training and workplace support into productivity gains. This result corresponds with the recent findings [21], who suggest that factors such as employee motivation, organizational culture, and leadership effectiveness play substantial roles in facilitating the transfer of training into measurable performance improvements.

From a practical standpoint, the findings imply that human capital development in the mining industry requires more than just technical training and favorable working conditions. Organizations must implement supportive systems to ensure the application of acquired skills in daily operations. Managerial approaches that empower employees and encourage the utilization of technical competencies are essential to maximize the return on training investments and foster long-term productivity improvements.

5 Discussion

5.1 *Comparison with Prior Research*

The findings of this study reveal that training and work environment have a significant direct effect on both technical skills and employee productivity. Furthermore, technical skills were also found to have a direct influence on productivity. These results are consistent with prior studies emphasizing the importance of human capital development in high-risk sectors. [1,15] highlighted that structured and relevant training programs can enhance employees' technical capabilities, which in turn contribute to improved work outcomes. Similarly, studies [10,11] affirmed that a supportive, safe, and comfortable work environment plays a vital role in facilitating technical competence development and work effectiveness.

However, contrary to expectations, the mediation test revealed that technical skills did not significantly mediate the effects of training and work environment on productivity. Although the direction of influence was positive, the indirect effects were not statistically significant ($p > 0.05$). This differs from the findings [14,21], which suggested that technical skills function as a key mechanism linking training to work outcomes. This discrepancy may be attributed to contextual

differences in industry settings or in how organizations implement training outcomes and manage workplace environments.

5.2 Limitations

This study This study acknowledges several limitations. First, the use of a cross-sectional design limits the ability to establish strong causal inferences, requiring caution when generalizing the findings. Second, the sample was drawn from only four coal mining companies in East Kalimantan Province, which may not fully represent the broader mining industry. Third, the use of self-reported questionnaires to measure variables may introduce perceptual bias from respondents. Additionally, the study only examined technical skills as the mediating variable. Other potential mediators such as work motivation, organizational culture, or leadership effectiveness—which could significantly influence the transformation of training and work environment into productivity—were not included in the model.

5.1 *LimitationsFuture Research*

Future research is encouraged to adopt a longitudinal approach to gain deeper insight into the long-term dynamics between training, work environment, and employee productivity. Expanding the sample to include more companies or different industry sectors would also enhance the generalizability of the findings.

It is recommended to explore additional mediating or moderating variables, such as job satisfaction, intrinsic motivation, organizational commitment, or leadership styles, which may clarify the mechanism by which training and work environment influence productivity. Employing a mixed-methods approach combining quantitative and qualitative techniques may also enrich understanding of the contextual and organizational factors that affect human capital development effectiveness in the mining sector.

6 Conclusion

This study aimed to examine the direct and indirect effects of training and work environment on employee productivity, with technical skills as a mediating variable, in the context of the mining industry. Using a quantitative approach and PLS-SEM analysis on data collected from 234 permanent employees in the technical and operational divisions of four coal mining companies in East Kalimantan, the study found that both training and work environment significantly and directly influence technical skills and employee productivity.

Moreover, technical skills were shown to have a significant direct effect on productivity. However, technical skills did not significantly mediate the relationship between training or work environment and productivity. These findings suggest that while improving technical capabilities is essential, other supporting factors may be required to fully translate training and work conditions into enhanced productivity.

This research contributes to the human resource development literature, especially within high-risk industries such as mining, by providing empirical evidence that emphasizes the need for integrated strategies that combine training, workplace quality, and organizational support systems. It also underlines the critical role of technical competencies while recognizing the limitations of relying solely on technical training without considering broader organizational dynamics.

7 Recommendation

The study recommends that mining companies invest not only in technical training but also in creating supportive work environments and post-training reinforcement mechanisms.

Organizational leaders should ensure training is aligned with operational needs and supported by leadership and culture that promote learning and application. For future research, scholars should explore other mediating or moderating variables—such as motivation or leadership style—to better understand how training and environmental factors contribute to productivity improvement.

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