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Systemic Breakdowns in Safety Defenses: An HFACS Analysis of Fatigue-Related Accidents and Organizational Failures in Coal Mining (2020–2024)

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Abstract

Background: Coal mining is among the industries with the highest risk of occupational accidents due to the complex interactions among humans, machines, and the environment. **Objective:** This study aims to analyze the causal factors of occupational accidents in the coal mining sector by reviewing 25 incident investigation reports from 2020 to 2024. **Methods:** A descriptive analysis using the Swiss Cheese Model and the Human Factors Analysis and Classification System (HFACS) was employed to identify systemic patterns and contributing factors. **Results:** The results indicate an increasing trend in incidents, rising from 5 cases (2020) to 10 cases (2024), with total material losses exceeding Rp 1.2 billion. Severity classification: Near Miss 2 cases (8%), Property Damage 16 cases (64%), First Aid Injury 5 cases (20%), and Lost Time Injury 2 cases (8%). The HFACS analysis identified failures at four levels: organizational influences (production pressure, inconsistent policies), inadequate supervision, unsafe conditions, and unsafe operator actions. Fatigue was identified as a consistent contributing factor in 100% of cases, manifesting as microsleep, insufficient sleep duration, and dishonesty in reporting physical condition. The gap analysis indicates that the simultaneous failure of multiple barriers is not due to random factors but rather systemic failures rooted in an organizational culture that prioritizes production. **Conclusion:** The occupational accidents that occurred were not caused by random factors, but rather a series of systemic failures culminating in operator fatigue. This study recommends an integrated approach to prevent incidents, which includes system strengthening (such as the utilization of monitoring technology and roster optimization), cultural transformation (from a blame culture to a learning culture), and consistent policy implementation with clear accountability across all organizational levels.

Keywords

Workplace Accidents, Coal Mining, Human Factors, Fatigue, Microsleep

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1. BACKGROUND

The mining industry is a high-risk sector due to the complexity of production processes, the use of heavy equipment, and dynamic, potentially hazardous work environments. This is emphasized in Decree of the Minister of Energy and Mineral Resources No. 1827 K/30/MEM/2018, which mandates the implementation of Good Mining Practices (GMP). This situation requires companies to implement a comprehensive and sustainable safety management system. Empirically, the mining sector is categorized as a high-risk industry with a high potential for accidents if not managed systematically (Mearns & Yule, 2009). Furthermore, regulations and standard operating procedures have not eliminated workplace incidents (Winge & Albrechtsen, 2020). Therefore, safety effectiveness is determined not only by the existence of a system, but also by the extent to which it influences work behavior in the field.

At the national level, mining safety management is implemented through the Mining Safety Management System (SMKP), as stipulated in Regulation of the Minister of Energy and Mineral Resources Number 26 of 2018. The SMKP is designed as a management framework encompassing planning, implementation, evaluation, and continuous improvement in safety management. Evaluation of safety implementation in mining is also conducted through a safety maturity level approach, which emphasizes that safety success is measured not only by the system's existence but also by the maturity level of its implementation within the organization. In other words, an organization with a safety system in place may not necessarily achieve optimal safety performance if the system has not been internalized in daily work practices. Safety performance evaluation is conducted through a safety maturity level approach based on Decree of the Director General of Mineral and Coal Number 10.K/MB.01/DJB.T/2023, which classifies organizations into basic, reactive, planned, proactive, and resilient levels. This approach emphasizes that safety success is determined not only by the system's existence but also by the maturity level of safety implementation and behavior within the organization. This phenomenon is reflected in the Safety Maturity Level (SML) assessment results for PT Putra Perkasa Abadi Jobsite PT Borneo Indobara (BIB) in 2025. The assessment results showed that the overall achievement level was 0.77 in the "planned" category, indicating that the safety system is in place and implemented but has not yet reached

an optimal level of maturity. In more detail, the worker participation indicator reached only 76%, while the safety analysis and statistics indicator was lower at 72%. These findings indicate a mismatch between the existence of a structured safety system and its effectiveness in the field, especially in worker involvement and the use of safety information for organizational learning.

This situation points to a more fundamental issue: the dominance of administrative safety approaches over behavioral approaches. From an organizational behavior perspective, safety performance is influenced by employee behavior, including safety compliance and safety participation (Griffin & Neal, 2000). Safety participation, which reflects the active involvement of employees in safety activities such as hazard reporting, consultation, and decision-making, plays a crucial role in improving the effectiveness of safety systems. Furthermore, Neal and Griffin (2006) show that safety behavior serves as a mediator between safety systems and workplace accidents, so a good system will not yield optimal performance without strong employee participation.

In this regard, safety leadership is a key factor in encouraging employee participation. Although safety leadership has been recognized as an important factor in improving employee safety behavior, approaches to understanding its influence on employee participation vary. One widely used approach is leadership style, which views leadership behavior as being manifested through specific style characteristics. Alegre-Quintana & Gutiérrez-Falcón (2025) classify leadership styles into four main categories: authoritarian, democratic, task-centered, and relationship-centered. Each leadership style has distinct characteristics in communication, decision-making, supervision, and employee involvement in safety activities.

Safety leadership is not only about the control function but also encompasses the leader's ability to foster communication, serve as a role model, and create a work environment that supports employee involvement in safety (Wu et al., 2008). Research by Clarke (2013) shows that leadership style significantly influences safety behavior and organizational safety performance. Thus, safety leadership can be viewed as a driving force that bridges formal safety systems with field safety practices.

However, the relationship between safety leadership and safety performance is not always direct. Several studies have shown that this influence is mediated by

employee involvement (Kahn, 1990; Schopf, 2021). Employee engagement reflects the level of active participation, concern, and engagement of workers in safety activities, which ultimately influences the effectiveness of safety system implementation. However, most previous studies have focused more on the relationship between leadership and safety performance in general, without specifically examining the role of leadership in encouraging employee participation within the framework of safety management system implementation, particularly in the mining industry.

Furthermore, research in the mining services industry, which is highly complex, is relatively limited, making the generalizability of findings from other sectors less relevant. This indicates a research gap stemming from a suboptimal understanding of the role of safety leadership in encouraging worker participation, a key factor in implementing mining safety. Furthermore, empirical evidence that safety maturity remains at the "planned" level indicates the need for a more focused approach to behavioral and leadership aspects.

This study aims to identify how different leadership styles influence worker participation levels in implementing mining safety and to determine the most effective leadership style in supporting safety culture improvement and the maturity of Mining Safety Management System (SMKP) implementation.

2. METHODS

This research uses an explanatory sequential mixed-methods approach, a mixed-methods approach implemented sequentially by combining quantitative and qualitative approaches within a single research framework. In this design, quantitative data collection and analysis are conducted first, followed by qualitative data collection and analysis to explain, deepen, and interpret the results obtained in the quantitative stage. This approach was chosen to gain a more comprehensive understanding of the relationship between safety leadership and worker participation in the implementation of mining safety.

In the first stage, the research used a quantitative, non-experimental, explanatory, and cross-sectional design. The aim was to identify respondent characteristics, measure research variables, and analyze the relationships and influences among leadership style, safety leadership, and worker participation in mining safety implementation.

In the second stage, in-depth interviews were conducted with informants purposively selected based on the quantitative findings. This aimed to explain the reasons, supporting factors, inhibiting factors, and the organizational context that influence the implementation of safety leadership and worker participation in mining safety implementation.

The final stage of this explanatory sequential mixed-methods design compared, connected, and interpreted findings from both methods to gain a deeper understanding of safety leadership styles based on the leadership style approach to worker participation in mining safety implementation.

This research was conducted at a coal mining private company operating in Tanah Bumbu Regency, South Kalimantan Province, which has implemented a Mining Safety Management System. The study location was selected purposively, with operational and supervisory employees categorized as such.

The sample size was determined using the Slovin formula. A stratified random sampling method was used to select 715 respondents, representing mine workers directly involved in mining activities.

Primary data was obtained through questionnaires administered to the sample workers. The questionnaires were used to measure safety leadership and worker participation in implementing mining safety. The measurement instrument for worker participation in the implementation of mining safety was based on an instrument developed by Alegre-Quintana & Gutiérrez-Falcón (2025) to measure the level of worker participation in the Occupational Safety and Health Management System. This instrument encompasses three main dimensions: information exchange, consultation, and involvement in decision-making (co-decision), consisting of 20 items.

Meanwhile, the measurement instrument for the safety leadership variable was developed based on the leadership style instrument used by Santos Sabino (2018). This instrument comprises four leadership dimensions: authoritarian leadership, democratic leadership, task-oriented leadership, and relationship-oriented leadership, comprising 33 items.

All items in both instruments were then adapted to reflect the implementation of mining safety and the operational characteristics of the mining companies in the study area without altering the substance of the constructs being measured. All variables were measured

using a five-level Likert scale (0–4), with higher scores indicating increasingly positive perceptions of safety leadership practices and worker participation in mining safety implementation.

The data obtained was processed and analyzed using SPSS software and Microsoft Excel. Univariate analysis in this study included safety leadership, safety climate, and safety performance.

Bivariate analysis was conducted as a preliminary analysis to identify the strength and direction of the relationship between each dimension of safety leadership style and worker participation. The results of the bivariate analysis served as the basis for selecting variables for further analysis in the multivariate stage.

Data obtained from the questionnaire used a Likert scale and were processed into scores for each dimension of the research variables. The relationship between each dimension of safety leadership style and worker participation was analyzed using the Spearman Rank correlation test. This test measures the strength of the relationship between two variables. Interpretation of the analysis results is based on the correlation coefficient (r) and the significance value (p-value). A relationship is considered statistically significant if the p-value is ‹0.05 at the 95% confidence level.

Multivariate analysis was conducted to identify the dimensions of safety leadership style that most dominantly influence worker participation, thus providing a basis for developing an appropriate safety leadership model to improve mining safety implementation.

The analytical method used was multiple linear regression because this study had one dependent variable and multiple independent variables analyzed simultaneously. The dependent variable in this study was worker participation in mining safety implementation, measured as the combined total score across the dimensions of information exchange, co-decision, and consultation. The independent variables consisted of four dimensions of safety leadership style: authoritarian, democratic, task-centered, and relationship-centered. Prior to conducting the multiple linear regression analysis, classical assumption tests were performed to assess normality, multicollinearity, and heteroscedasticity, ensuring the data met the regression analysis requirements.

The regression analysis was conducted using simultaneous (F tests), partial (t tests), and coefficient of determination (R^2) tests. The simultaneous test (F tests) was used to determine whether all dimensions of safety

leadership style jointly influenced worker participation in mining safety implementation. Independent variables were considered to have a simultaneous influence if the p-value ‹0.05 was obtained.

A partial t-test was used to determine the effect of each safety leadership style dimension on worker participation after controlling for other leadership style dimensions in the model. A variable was considered significantly influential if its p-value was ‹0.05 at the 95% confidence level. The coefficient of determination (R^2) was used to determine the contribution of all safety leadership style dimensions in explaining variations in worker participation in safety implementation.

Qualitative data analysis in this study was conducted to explain and deepen the results of the quantitative analysis regarding the influence of safety leadership styles on worker participation in mining safety implementation. The main components of data analysis include data condensation, data display, and conclusion drawing and verification.

The first stage is data condensation, which is the process of selecting, focusing, simplifying, abstracting, and transforming interview data to obtain information relevant to the research objectives. This stage involves transcription, coding, categorization, and identification of themes related to safety leadership styles and worker participation. The second stage is data presentation, which organizes the condensed data into narratives, matrices, tables, or theme maps to facilitate researchers' understanding of the relationships between categories and emerging themes. The third stage is conclusion drawing and verification, which is the process of interpreting the patterns, relationships, and themes identified in the data. Conclusions are continuously verified throughout the research process by comparing various information sources and analysis results, resulting in credible and reliable findings.

In this study, qualitative analysis results were used to explain the quantitative findings from the regression analysis, particularly regarding the dimensions of safety leadership style that most influence worker participation in implementing mining safety.

The validity of qualitative data in this study refers to the concept of trustworthiness, which consists of four main criteria: credibility, transferability, dependability, and confirmability. Credibility is achieved through source and method triangulation. Source triangulation is achieved by comparing information obtained from workers, supervisors, and

management, while method triangulation is achieved by comparing the results of interviews, field observations, document reviews, and quantitative survey results. Transferability is achieved by presenting detailed descriptions of the characteristics of the research location, informants, and mining safety implementation, enabling readers to assess the relevance of the research results to other similar issues. Dependability is achieved by systematically documenting the entire research process through an audit trail, from data collection, coding, theme analysis, to drawing conclusions. Confirmability is achieved by ensuring that all research findings are based on empirical data obtained from informants and field evidence. To maintain objectivity, researchers keep records of interviews, observation results, supporting documents, and present relevant informant quotes as supporting evidence for research interpretation.

Research This research has obtained ethical approval from the Research Ethics and Community Health Service Commission of the Faculty of Public Health, University of Indonesia (Ket-514/UN2.F10.ETK/PPM.00.02/2026). The researchers applied the principles of research ethics, including respecting respondents' rights, maintaining data confidentiality, and ensuring voluntary participation. All information obtained from respondents is kept confidential and presented in aggregate form so that it cannot identify individual respondents.

3. RESULTS

Table 1. Respondent Characteristics (n=715)

Characteristic	Category	n	%
Position	Operational	430	60.1
	Supervisor	285	39.9
Gender	Male	696	97.3
	Female	19	2.7
Age (years)	≤25	147	20.6
	26-35	420	58.7
	36-45	138	19.3
	>45	10	1.4
Education	Junior High School	3	0.4
	Senior High School	621	86.9
	Diploma	14	2.0
	Bachelor	77	10.8
Work Tenure	<1 year	109	15.2
	1-2 years	176	24.6
	3-4 years	190	26.6
	>5 years	240	33.6

Table 1 presents the demographic characteristics of the 715 respondents. The majority were operational workers (60.1%), male (97.3%), aged 26-35 years (58.7%), with senior high school education (86.9%), and had more than five years of work experience (33.6%). This profile reflects the typical workforce composition in the Indonesian mining industry.

Table 2. Descriptive Statistics of Study Variables (n=715)

Variable	Mean	SD
Safety Leadership		
Authoritarian	2.8	0.8
Democratic	3.0	0.6
Task-centred	3.4	0.6
Relationship-centred	3.5	0.7
Worker Participation		
Information Exchange	3.5	0.5
Decision-Making Involvement	2.9	1.0
Consultation & Participation	3.3	0.8

Table 2 presents descriptive statistics for all study variables. Relationship-centred leadership showed the highest mean score (M=3.5, SD=0.7), followed by task-centred leadership (M=3.4, SD=0.6). For worker participation, information exchange and communication scored highest (M=3.5, SD=0.5), while involvement in decision-making was lowest (M=2.9, SD=1.0).

Table 3. Spearman Correlation Analysis

Variable	r	p-value
Authoritarian	0.264	<0.001
Democratic	0.622	<0.001
Task-centred	0.688	<0.001
Relationship-centred	0.684	<0.001

Spearman correlation analysis (Table 3) revealed that all safety leadership dimensions had significant positive correlations with worker participation (p<0.001). Task-centred leadership showed the strongest correlation (r=0.688), followed by relationship-centred leadership (r=0.684) and democratic leadership (r=0.622).

Table 4. Multiple Regression Analysis Results

Predictor	B	β	t	p	VIF
Constant	0.750	-	7.191	<0.001	-
Authoritarian	-0.028	-0.035	-0.893	0.372	2.14
Democratic	0.291	0.292	5.518	<0.001	3.93
Task-centred	0.305	0.295	4.521	<0.001	5.98
Relationship-centred	0.196	0.200	3.266	0.001	5.25

Note: R^2=0.494, Adjusted R^2=0.491, F=173.227, p<0.001

Multiple regression analysis was conducted to examine the effects of safety leadership dimensions on worker participation. The model was statistically significant ($F=173.227$, $p<0.001$) and explained 49.4% of the variance (Adjusted $R^2=0.491$). No multicollinearity was detected (all VIF<6.0).

Table 4 shows that task-centred leadership ($\beta=0.295$, $p<0.001$), democratic leadership ($\beta=0.292$, $p<0.001$), and relationship-centred leadership ($\beta=0.200$, $p=0.001$) significantly predicted worker participation, while authoritarian leadership was not significant ($p=0.372$).

Qualitative analysis identified five major themes (Table 5). Workers emphasized that clear direction and supervision facilitated safety engagement: "When work directions are clear and supervision is running well, workers find it easier to follow safety procedures" (W-02).

Two-way communication enabled participation: "Good communication makes workers braver to report hazards and provide input" (W-09). Positive relationships built trust for discussing safety issues. However, decision-making involvement remained limited to consultation rather than actual decision authority. Finally, authoritarian approaches ensured compliance but did not foster active engagement.

Table 5. Qualitative Themes and Illustrative Quotes

Theme	Category	Illustrative Quote
Clear direction enhances participation	Task-centred	"Clear directions and supervision make workers easier to follow safety procedures" (W-02)
Two-way communication increases involvement	Democratic	"Good communication makes workers braver to report hazards" (W-09)
Positive relationships build trust	Relationship-centred	"We are comfortable conveying safety issues to supervisors" (FGD-09)
Decision-making involvement limited	Participation	"Decisions on safety procedures remain at management level" (W-06)
Authoritarian approach limits engagement	Authoritarian	"Rigid instruction makes workers compliant but not actively participate" (W-08)

4. DISCUSSION

This study examined the influence of safety leadership styles on worker participation in mining safety implementation. The main finding is that task-centered leadership, democratic leadership, and relationship-centered leadership significantly predict worker participation, collectively explaining 49.4% of its variance. Notably, task-centered leadership emerged as the most

dominant predictor (β=0.295), followed closely by democratic leadership (β=0.292) and relationship-centered leadership (β=0.200). Conversely, authoritarian leadership did not significantly influence worker participation. These findings provide important insights into the effectiveness of safety leadership in high-risk mining operations.

Task-Centered Leadership as the Primary Driver of Worker Participation

The dominance of task-centered leadership in predicting worker participation aligns with the high-risk nature of coal mining operations. Workers require clear work instructions, consistent safety supervision, and strict adherence to safety procedures to navigate complex operational hazards effectively. Our qualitative findings revealed that supervisors routinely conduct toolbox meetings, Job Safety Analysis discussions, and pre-work briefings, which workers perceive as essential for understanding job risks and control measures before commencing work.

This finding supports previous research demonstrating that task-oriented leadership is particularly effective in high-hazard industries where procedural compliance and risk control are paramount (Alegre-Quintana & Gutiérrez-Falcón, 2025; Ta et al., 2022). In mining contexts, where workers face hazards from heavy equipment operations, hauling, dumping, and blasting, clear directional leadership provides the structural framework for safe work execution. Workers are more likely to participate actively in safety programs when they understand their tasks, associated risks, and required control measures.

However, the effectiveness of task-centered leadership in our study stems not from rigid command-and-control approaches but from systematic risk communication and work planning. This interpretation is consistent with modern safety leadership theories that emphasize the importance of operational clarity combined with worker engagement (Santos-Sabino, 2019). The finding suggests that in high-risk industries, task orientation and worker participation are complementary rather than contradictory objectives.

The Complementary Role of Democratic and Relationship-Centered Leadership

The significant influence of democratic leadership (β = 0.292) indicates that two-way communication and worker consultation substantially enhance safety participation. Our findings show that workers actively engage in safety talks,

toolbox meetings, and safety consultations, where they can voice concerns, report hazards, and suggest improvements. This participative approach aligns with Social Exchange Theory, which posits that workers reciprocate organizational support by increasing their commitment and participation (Blau, 1964).

The strong correlation between democratic leadership and worker participation (r=0.622) corroborates previous research demonstrating that participative leadership enhances safety engagement by fostering psychological ownership and intrinsic motivation (Niu & Liu, 2022; Millana et al., 2024). When workers perceive that their input is valued and considered, they develop a stronger commitment to safety objectives. They are more willing to engage in voluntary safety behaviors beyond minimum compliance requirements.

Relationship-centered leadership also demonstrated significant influence (β = 0.200), albeit with a smaller effect size than task-centered and democratic leadership. This finding suggests that supportive supervisor-worker relationships, characterized by trust, open communication, and mutual respect, create psychological safety conditions that encourage workers to report hazards and safety concerns without fear of negative consequences. Our qualitative data revealed that workers feel more comfortable discussing safety issues with supervisors who demonstrate care, accessibility, and responsiveness.

This finding supports research indicating that high-quality leader-member exchange relationships enhance safety participation through increased trust and psychological safety (Niu & Liu, 2022). In mining operations, where workers may hesitate to report near-misses or unsafe conditions due to production pressures or fear of blame, supportive leadership relationships are crucial for maintaining open communication about safety.

The Limited Role of Authoritarian Leadership

The non-significant influence of authoritarian leadership on worker participation, even after controlling for other leadership dimensions, represents an important finding. While authoritarian leadership showed a weak positive correlation with participation in bivariate analysis (r=0.264), its effect became non-significant in the multivariate model. This suggests that directive, top-down approaches may ensure basic compliance but do not foster active worker engagement in safety programs.

Our qualitative findings revealed that while workers acknowledge the necessity of firm directives in high-risk situations, overly authoritarian approaches tend to suppress initiative and discourage proactive safety participation. Workers comply with instructions but remain passive in offering suggestions or engaging in safety improvement activities. This finding aligns with contemporary safety literature, which emphasizes that sustainable safety performance requires active worker engagement rather than mere compliance (Alegre-Quintana & Gutiérrez-Falcón, 2025; Leazer & Freeman, 2025).

However, the continued presence of authoritarian leadership elements in our study context reflects the reality of high-risk mining operations where immediate compliance with safety directives may be necessary in certain situations. The key distinction is that effective safety leadership in mining combines necessary directive elements with participative and supportive approaches, rather than relying exclusively on command-and-control methods.

Patterns of Worker Participation

The finding that worker participation is highest in information exchange and communication (mean=3.5) but lowest in decision-making involvement (mean=2.9) reveals important insights about the maturity of safety participation in the studied organization. This pattern suggests that while the company has established effective safety communication mechanisms, worker involvement in actual safety decision-making remains limited.

This finding reflects the typical progression of worker participation described in ILO frameworks, in which organizations advance from information sharing to consultation before achieving genuine co-decision-making (ILO, 2001; EU-OSHA, 2012). Our qualitative data confirmed that while workers can provide input through various forums, final decisions on safety procedures and policies remain at supervisory and management levels.

This limitation represents an opportunity for organizational development. Research indicates that deeper worker involvement in safety decision-making enhances ownership, improves the quality of safety decisions through frontline expertise, and strengthens safety culture (Hassard et al., 2017). Organizations seeking to advance their safety performance should consider expanding worker involvement in hazard

identification, risk assessment, procedure development, and safety program evaluation.

Theoretical Implications

This study contributes to safety leadership theory by demonstrating that effective safety leadership in high-risk mining contexts requires a balanced combination of task orientation, democratic participation, and relationship support. The findings challenge simplistic dichotomies between task-focused and people-focused leadership, showing that both dimensions are essential and complementary in high-hazard environments.

The results support integrated safety leadership models that recognize the multidimensional nature of safety leadership effectiveness (Santos-Sabino, 2019). Rather than advocating for a single "best" leadership style, our findings suggest that context-appropriate combinations of leadership behaviors are necessary. In mining operations, this means maintaining strong operational control and procedural compliance while simultaneously fostering open communication, worker consultation, and supportive relationships.

Practical Implications

For mining organizations, these findings suggest several practical implications. First, leadership development programs should emphasize task-centered leadership competencies, including work planning, risk communication, safety supervision, and procedural enforcement. Supervisors must be equipped to provide clear safety directions and maintain consistent oversight of high-risk activities.

Second, organizations should strengthen democratic leadership practices by establishing robust safety consultation mechanisms, encouraging two-way communication, and genuinely considering worker input in safety decisions. This requires training supervisors in facilitation, active listening, and participative decision-making.

Third, frontline leaders should develop relationship-building capabilities to create psychologically safe environments where workers feel comfortable raising safety concerns. This includes demonstrating care for worker wellbeing, providing constructive feedback, and recognizing safety contributions.

Fourth, organizations should progressively expand worker involvement in safety decision-making beyond consultation to genuine participation in hazard identification, risk assessment,

procedure development, and safety program evaluation.

Limitations

This study has several limitations. First, the cross-sectional design limits causal inferences about the relationship between safety leadership and worker participation. Longitudinal studies would provide stronger evidence of causal relationships. Second, the study was conducted in a single coal mining services company in Indonesia, which may limit generalizability to other mining contexts or industries. Third, reliance on self-reported measures may introduce common-method bias, though the use of mixed methods helps mitigate this concern. Fourth, the male-dominated sample (97.3%) reflects industry characteristics but limits understanding of gender differences in perceptions of safety leadership. Future research should examine these relationships across diverse mining contexts and explore potential moderating factors such as organizational culture, safety climate, and individual differences.

5. CONCLUSION

This study examined the influence of safety leadership styles on worker participation in mining safety implementation at an Indonesian coal mining services company. The findings demonstrate that task-centered leadership, democratic leadership, and relationship-centered leadership significantly predict worker participation, collectively explaining 49.4% of its variance. Notably, task-centered leadership emerged as the most dominant predictor (β=0.295), followed closely by democratic leadership (β=0.292) and relationship-centered leadership (β=0.200). In contrast, authoritarian leadership did not significantly influence worker participation despite showing a weak positive correlation in bivariate analysis.

The dominance of task-centered leadership reflects the high-risk nature of mining operations, where workers require clear safety directions, consistent supervision, and strict procedural compliance to navigate complex operational hazards. However, the effectiveness of this approach stems not from rigid command-and-control methods but from systematic risk communication, work planning, and collaborative safety discussions. The significant influence of democratic and relationship-centered leadership further indicates that effective safety leadership in mining requires balancing operational control with

participative communication and supportive relationships.

Worker participation was highest in information exchange and communication but lowest in decision-making, suggesting that while safety communication mechanisms are well-established, there remains a substantial opportunity to deepen worker involvement in actual safety decision-making. This finding indicates that the organization has developed strong consultative practices but has not yet fully established co-decision-making arrangements.

These findings contribute to the safety leadership literature by demonstrating that, in high-risk mining contexts, effective safety leadership requires an integrated approach that combines clear operational direction, open two-way communication, and supportive interpersonal relationships. Organizations seeking to enhance worker participation should focus on developing supervisors' capabilities in work planning, risk communication, participative decision-making, and relationship building, while progressively expanding worker involvement beyond consultation to genuine participation in safety decision-making processes.

AUTHOR CONTRIBUTIONS

SFW was responsible for conceptualization, design, data collection, data analysis, and manuscript preparation. RM supervised the research process, and methodological. All authors contributed to data interpretation and provided critical review and final approval of the manuscript.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest in this research.

DATA AVAILABILITY STATEMENT

The data are available from the corresponding author upon reasonable request.

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