Keselamatan Dahulu, Keselamatan Selalu: Bagaimana Komunikasi Mendorong Kepatuhan melalui Budaya di Perusahaan Pertambangan Berisiko Tinggi

Safety First, Safety Always: How Communication Drives Compliance through Culture in High-risk Mining Company

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Abstrak

Keamanan di industri berisiko tinggi seperti pertambangan tetap menjadi perhatian global yang kritis. Meskipun pentingnya komunikasi keamanan yang efektif telah diakui, mekanisme yang memfasilitasi kepatuhan jangka panjang dan integrasinya dengan budaya keamanan organisasi masih kurang dieksplorasi, terutama di Indonesia. Studi ini bertujuan untuk mengisi celah tersebut dengan menganalisis bagaimana komunikasi keamanan memengaruhi kepatuhan dan menyoroti peran budaya keamanan organisasi dalam memediasi kepatuhan. Menggunakan pendekatan kuantitatif, data dikumpulkan dari 204 karyawan perusahaan pertambangan berisiko tinggi di Indonesia (PT X) melalui survei digital yang dilakukan pada Oktober 2024. Model Proses Hayes 4, dengan pendekatan bootstrapping sebanyak 5.000 sampel, digunakan untuk mengevaluasi hubungan antara komunikasi keselamatan, budaya keselamatan, dan kepatuhan. Temuan menunjukkan bahwa komunikasi keselamatan secara langsung mempengaruhi kepatuhan dan secara tidak langsung melalui mediasi budaya keselamatan. Mediasi parsial ini menyoroti peran penting budaya keselamatan dalam memperkuat dampak komunikasi yang efektif. Dengan fokus pada sektor pertambangan Indonesia, studi ini secara unik mengatasi tantangan kontekstual industri berisiko tinggi dan menawarkan wawasan yang dapat diterapkan pada sektor serupa secara global. Temuan ini mengisi celah kritis dalam pemahaman interaksi antara faktor komunikasi dan budaya dalam kepatuhan keselamatan. Organisasi dapat memanfaatkan temuan ini untuk merancang strategi komunikasi yang ditargetkan dan inisiatif penguatan budaya, memastikan kepatuhan yang berkelanjutan dan lingkungan kerja yang lebih aman.
Kata Kunci: Budaya Keselamatan Organisasi; Industri Berisiko Tinggi; Kepatuhan Keselamatan; Komunikasi Keselamatan; Sektor Pertambangan.

Abstract

Safety in high-risk industries like mining remains a critical global concern. Despite the acknowledged importance of effective safety communication, the mechanisms through which it fosters long-term compliance and integrates with organizational safety culture are underexplored, particularly in Indonesia. This study aims to fill this gap by examining how safety communication influences compliance and highlighting the role of organizational safety culture in mediating compliance. Using a quantitative approach, data were gathered from 204 employees of an Indonesian high-risk mining company (PT X) through a digital survey conducted in October 2024. The Hayes Process Model 4, with a bootstrapping approach of 5000 samples, was employed to evaluate relationships between safety communication, safety culture, and compliance. Findings indicate that safety communication directly affects compliance and indirectly affects safety culture. This partial mediation underscores the safety culture's essential role in enhancing effective communication. By focusing on Indonesia's mining sector, this study uniquely addresses the contextual challenges of a high-risk industry and offers insights applicable to similar sectors globally. The findings bridge a critical gap in understanding the interplay between communication and cultural factors in safety compliance. Organizations can leverage these findings to design targeted communication strategies and cultural reinforcement initiatives, ensuring sustained compliance and safer working environments.
Keywords: High-Risk Industries; Mining Sector; Organizational Safety Culture; Safety Communication; Safety Compliance.

INTRODUCTION

Workplace safety remains a significant global issue, especially in high-risk industries like mining, where workers are continually exposed to hazardous conditions and severe environmental risks. The mining sector is notably among the most dangerous industries due to its high incidence of occupational accidents and fatalities (Jiang et al., 2019). In Indonesia, particularly in the energy sectors such as oil, gas, and mining, the workplace accident rates remain notably high, underscoring an urgent demand for effective safety measures (ESDM, 2024). The consequences of workplace accidents are severe, negatively impacting employees' physical and psychological health and causing substantial financial and reputational damage to organizations. The International Labor Organization (2021) reported over 2.78 million annual deaths globally due to occupational incidents and diseases, accompanied by more than 374 million non-fatal injuries. Specifically, in Indonesia, between January and August 2024 alone, 278,564 reported workplace accidents, predominantly affecting wage earners (91.86%), emphasizing the critical need for robust safety strategies (Kemnaker, 2024).

The mining industry was one of the earliest efforts in the development of human civilization, providing support in agriculture. The role of mining remains significant and unchanged for society today (Singh et al., 2018). Mining operations inherently involve significant risks due to complex extraction processes and hazardous environments. Ore extraction remains a crucial element in modern civilization, providing valuable minerals necessary for various industries (Hartman, 1987; Hartman & Mutmansky, 2002). Ore itself is a rock containing valuable minerals such as gold, silver, copper, and nickel that can be converted in salable products and generate financially acceptable profits under economic conditions (Hamrin, 1980). Despite its necessity, mining consistently ranks among the industries with the highest potential for catastrophic accidents (Jiang et al., 2019; Çakıt *et al.*, 2020). Historical disasters such as the Deepwater Horizon explosion in 2010 highlight severe outcomes arising from inadequate safety compliance and ineffective organizational communication, illustrating the essential role of comprehensive safety systems (BP Accident Report, 2010). Effective safety protocols not only prevent accidents but also foster a proactive safety culture within the organization (Singh et al., 2018).

Safety compliance, characterized as obedience to core activities designed to ensure a safe working environment, significantly depends on organizational culture and effective internal communication (Griffin & Neal, 2000). Compliance emerges from interactions at various organizational levels, team dynamics, and individual psychological processes (Bisbey et al., 2021). Borman & Motowidlo (Borman & Motowidlo, 1993) categorized workplace performance into task and contextual performance, where safety compliance constitutes an essential form of task performance aimed explicitly at preventing workplace incidents (Griffin & Neal, 2000; Neal & Griffin, 2006).

Safety culture has become an increasingly critical mechanism to mitigate large-scale industrial accidents by

addressing underlying behavioral dimensions and promoting preventive practices (Abdelhamid et al., 2000; Jiang et al., 2019). Effective safety culture includes employee safety participation, perceived risks, and emergency response capabilities (Wu et al., 2009). Positive safety behaviors fostered by robust safety culture directly correlate with reduced accident rates and enhanced safety performance in mining operations (Ismail et al., 2021). Organizations that embed safety within their core values demonstrate significantly better safety outcomes, emphasizing the need for integrating safety values into daily organizational behaviors (Cooper, 2000).

Safety communication emerges as a pivotal factor in reinforcing safety culture and compliance. This communication contains efforts to improve safety performance by encouraging safe behaviors, providing feedback, and applying to be-taught safety programs (Rashid et al., 2014). Effective communication within an organization significantly influences employees' adherence to safety procedures, thereby reducing accidents (Harper et al., 1996; Tan-Wilhelm et al., 2000). Continuous, transparent communication not only reflects organizational commitment to employee well-being but also directly correlates with improved safety outcomes (Michael *et al.*, 2006). Research by Hofmann & Stetzer (1998) and Kines et al. (2010) reveals that consistent and engaged safety communication substantially enhances employee compliance and reduces accident risks through immediate identification and management of safety concerns.

PT X exemplifies an organization deeply committed to workplace safety, embedding safety as a foundational value in its operations. The company integrates safety into its core values, represented by the acronym SINCERE (Safety, Integrity, Commitment, Respect, Excellence), guiding behavior at all organizational levels. Consistent implementation of safety training programs, leader involvement, and rigorous compliance enforcement have significantly reduced workplace accidents, demonstrating PT X's successful approach to fostering a sustainable safety culture.

Despite these advancements, there remains a gap in comprehensive research examining the dynamic relationship between safety communication, organizational culture, and employee compliance with safety norms. This study aims to bridge this gap by exploring how systematic and effective safety communication influences safety compliance within the high-risk mining sector in Indonesia, with organizational culture acting as a mediating factor. Understanding this interplay not only contributes to enhancing occupational safety practices within Indonesia's mining sector but also provides actionable insights applicable globally, addressing the universal challenge of workplace safety in hazardous industries.
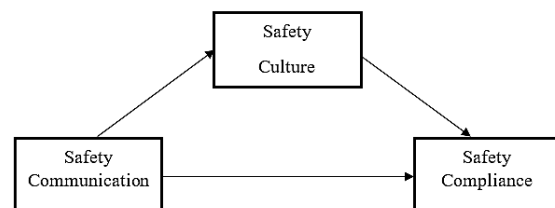

Figure 1. Research Model
source: author's work

Based on the description above, the following hypotheses are proposed:

H1: Safety communication has a positive and significant effect on safety culture

H2: Safety culture mediates the relationship between safety communication and safety compliance

RESEARCH METHODS

This quantitative research examines the relationship between the variables that influence safety compliance in the mining industry. This study has met the ethical research standards set by the Research Ethics Committee at the Faculty of Psychology, University of Indonesia, Indonesia. Data was collected using a digital survey through Google Forms, which included an introduction, informed consent, and filling instructions. The research instrument consists of a questionnaire that measures safety communication variables. The instrument has been previously validated in earlier studies. The data were then analyzed using the Hayes PROCESS Model 4 method.

The study population was employees in a high-risk mining company. The core activities in the company's work operations involve mine exploration to depths of more than 4 KM below ground and reaching mine tunnel traveling lengths of more than 500 KM, working in the dark, work operations with heavy equipment such as crushers and rock haulers, use of explosives, interaction with mine concentrate reaction chemicals, long-term exposure to mineral dust, mechanical activities of mineral smelting with extensive machinery. The company also operates non-stop 365 days a year, which

demands rigorous operations and implies that operations must go on without incident, even during regular human sleeping hours. In addition to this, all activities within the company carry a high risk of fatality in the form of falls from heights, mine tunnel avalanches, wet mudslides, risks of being run over by large vehicles, being hit by operating machinery and many other potential safety and health hazards if work is not carried out in compliance with safety norms.

The sample was selected using the convenience sampling technique, a non-probability sampling method based on the availability of elements and ease of access (Sugiyono, 2013). The required sample size was determined through power analysis using the GPower application. The minimum number of samples used in this study is 146 participants, with a predictor count (independent variables) of six, a significance level of 0.05, an assumed medium effect size of 0.15, and a standard power of 0.95.

The research instrument was adapted into Indonesian following the adaptation procedure for measurement tools by Beaton et al. (2000). A pilot study was conducted with 30 participants, and the reliability of the adapted measurement tool was tested using Cronbach's alpha coefficient. Data collected from the survey were analyzed, and items were selected to test the research hypotheses. Subjects' responses to each statement were measured using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

Safety compliance is measured using an instrument developed by Griffin & Neal (2000), which consists of seven items, one of which states, "I perform my job in a safe

manner." The Cronbach's alpha reliability test result is 0.888. Safety culture is measured using the Safety Culture Scale (SCS) developed by Wu et al. (2010), which includes three dimensions (emergency response, risk perception, and employee safety participation) with a total of 12 items. An example of one item states, "My coworkers understand safety procedures in the event of a work accident." The Cronbach's alpha reliability test result is 0.883. Safety communication is measured using an instrument adapted to Indonesian by Ansori et al. (2021), which consists of four items, for example, "There is open communication regarding safety in the workplace," with a Cronbach's alpha reliability test result of 0.861.

RESULTS AND DISCUSSION

Table 1. Respondent Information

Gender	Freq	%
Male	168	82.353
Female	36	17.647
Age group	Freq	%
20-39 years old	122	59.804
40-64 years old	81	39.706
65 years old and above	1	0.490
Educational level	Freq	%
High School graduate	72	35.294
Undergraduate and diplomas	13	6.373
Bachelor's degree graduates	97	47.549
Master's degree graduates	22	10.784
Work experience	Freq	%
1-5 years	57	27.941
6-10 years	60	29.412
11-15 years	38	18.627
16-20 years	25	12.255
21-25 years	24	11.765
Employment status	Freq	%
Permanent employee	116	56.863
Contract-based employee	86	42.157
Fresh Graduate Program	2	0.980
Work field	Freq	%
Operation	140	69
Support	64	31
Total	204	100.000

Although the minimum requirement for the number of samples in this study is only 146 participants, during the process of distributing the questionnaires in the first and second weeks of October 2024, a total of 210 participants was obtained. From this number, 204 respondents were found to have usable data because 6 participants indicated unengaged responses while completing the questionnaire.

Demographic data of the participants showed that the majority of respondents were in the early adult age range of 20-39 years (122; 59.8%; M=37.98; SD=8.81), dominated by male gender with 168 people, or 82.3%, while female respondents numbered 36 or 17.6%. In general, participants consisted of more D4 / S1 graduates (47.5%), followed by SMA / equivalent (35.2%), S2 (10.7%) and D1 / D2 / D3 (6.4%). The study participants were found to have varied work experience, but the largest distribution was those with 6-10 years of experience at 29.4% (M=2.50; SD=1.33), followed by more than 20 years of experience at 11.7%. The majority of participants were permanent employees (56.8%), while contract employees accounted for 42.2%. The rest of the participants were fresh graduate program workers who worked in the operational division (69%), while the remaining 31% worked in the support division (M=1.59; SD=0.49).

Data for each variable was collected simultaneously, so Harman's single-factor test was used to identify potential common method bias (CMB). Indications of CMB can be seen if one factor explains more than 50% of the total variance. The analysis results show that the factor explains 43.513% of the total variance, which is below the 50% threshold. Therefore, the

data in this study is considered to be sufficiently free from the influence of CMB.

Table 2. Harman's single-factor test

Component	Extraction sum of squared loadings		
	Total	% of Variance	Cumulative %
1	13.48	43.51	43.51

Notes: Harman's single factor test resulted in lower than 50% score
Source: SPSS IBM ver 22

After ensuring that the measurements were free from indications of common method bias, hypothesis testing was carried out using Hayes' Macro process model no. 4 to examine the direct effects of safety communication on safety compliance and to confirm whether safety culture could act as a mediator in that relationship. The results of the testing presented in Table 3 reveal that even with the presence of safety culture as a mediator, safety communication has a positive and significant direct impact on safety compliance (β: 0.673; B: 0.215; t: 11.88; p = 0.000). Thus, Hypothesis 1 is supported by the data. Safety communication continues to have a direct influence on safety compliance, even through safety culture as a mediator, indicating that the direct relationship between safety communication and safety compliance remains positive even when accounting for the mediator (safety culture).

Indirect relationship testing shows that safety culture can mediate the relationship between safety communication and safety compliance (β: 0.103; B: 0.032; p = 0.000). Although the mediating effect is relatively small, these findings support that Hypothesis 2 is also backed by the data. Meanwhile, the total effect between safety communication and safety compliance in this measurement model is positive and significant (β: 0.776; B: 0.248; t: 17.50; p: 0.000). Overall, safety communication has a strong and significant direct relationship with safety compliance. This demonstrates that employee compliance with the applicable safety protocols and norms in the company can be effectively built through the implementation of strong safety communication within the organization. Strong safety communication also positively impacts the formation of an organizational culture; in other words, the safety culture experienced by employees while working can be facilitated through effective safety communication patterns. The implementation of effective safety communication at PT X can help the company build a stronger safety culture and positively contribute to employees' willingness to comply with the safety norms and protocols established by the company while working.

Table 3. Hypotheses testing

Efek	B	SE	t	p	CI 95% [LL, UL]	β
c	0.248	0.014	17.50	.000	[0,220, 0,276]	0,776
c'	0.215	0.018	11.88	.000	[0,179, 0,251]	0,673
ab	0.032	0.013			[0,007, 0,058]	0,103

Notes: c = total effect; c' = direct effect; ab = indirect effect
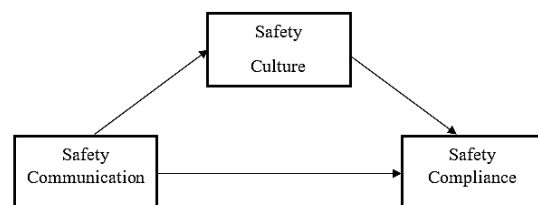Source: SPSS IBM ver 22

Figure 1. Measurement model
Source: author's work

CONCLUSION

This study underscores the critical role of safety communication in fostering compliance within high-risk industries.

The findings reveal that clear, open, and continuous safety communication significantly enhances employees' obedience to safety protocols. Moreover, safety culture acts as a partial mediator, reinforcing the influence of communication on compliance. When employees operate within a strong safety culture, compliance becomes more instinctive, further reducing workplace risks. Beyond confirming existing research on the importance of communication and culture in shaping safety behavior, this study highlights the necessity of leadership-driven initiatives. Organizations must integrate safety communication strategies not just as informational tools, but as mechanisms for shaping workplace norms and behaviors. Establishing open communication channels encourages employees to actively participate in safety discussions, fostering a culture where adherence to protocols is deeply embedded.

From a practical standpoint, companies, particularly in the mining sector, should prioritize structured communication programs, leverage technological advancements for real-time safety updates, and cultivate leadership that actively supports and reinforces safety norms. These approaches can contribute to long-term improvements in compliance and overall workplace safety. Future research should explore additional variables influencing safety compliance, such as psychological factors, technological interventions, and cross-cultural differences in safety behaviors. Investigating how evolving workplace dynamics impact compliance can refine safety frameworks, ensuring adaptable and effective strategies across industries.

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