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Original Article

The Influence of Mine Technical Head's Safety Leadership on Safety Behavior of Heavy Equipment Operators in Mining Con tractors: The Mediating Role of Safety Knowledge

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Abstract: *The Mine Technical Head, known as Kepala Teknik Tambang (KTT) in Indonesian, holds the highest position in mining operations and is responsible for the safety of all workers within the operational area. This includes the safety supervision of mining contractor workers as project executors. Many studies on safety leadership focus on the relationship between leaders and subordinates within an organizational structure. However, research needs to study the influence of project owners' safety leadership on their contractor workers, especially in the Indonesian mining industry. This study aims to fill this gap by assessing the impact of the KTT's safety leadership as a mining project owner on the safety behavior of heavy equipment operators employed by contractors. This research was conducted by randomly distributing questionnaires to heavy equipment operators who work with different contractors. Analyzing data from 347 respondents using the Structural Equation Modeling-Partial Least Squares (SEM-PLS) method, the results indicate a direct positive influence of the KTT's safety leadership on the safety behavior of heavy equipment operators even though the relationship is not within the same organizational structure. Safety Knowledge as a mediating variable does not change the results of the study, so it is classified as a partial mediator.*

Keywords: *Safety Leadership, Safety Knowledge, Safety Behavior, Mining Contractor, Mine Technical Head.*

I. INTRODUCTION

The coal mining industry is one of the high-risk industries, particularly concerning worker safety. According to mining accident data issued by the Indonesian Ministry of Energy and Mineral Resources in 2023, 75% of incidents occurred among mining contractor workers. The mining accident data reported for 2020 also indicates that accidents stem from personal and work-related factors. Specifically, personal factors, such as a lack of knowledge, contribute significantly (44%), while work factors, such as inadequate quality leadership and supervision, also play a role (34%).

Research consistently shows that management commitment to safety positively correlates with safety behavior among workers (Xue et al., 2020; Ye et al., 2020; Niu et al., 2022; Ismail et al., 2021). Griffin & Neal (2006) emphasized the close relationship between safety behavior and accident occurrence. This aligns with H.W. Heinrich's theory (1931), which posits that 88% of accidents result from unsafe acts or behaviors by humans.

Interestingly, while many studies explore the direct relationship between the safety leadership of management or supervisor and the safety behavior of subordinates within an organizational structure, research rarely investigates the influence of safety leadership across different organizational structures, especially the impact of head project owners' leadership on contractor workers. This study aims to fill this gap by assessing the impact of the KTT's safety leadership, as the head of a mining project owner, on the safety behavior of contractor workers and evaluating the mediating role of safety knowledge between these two relationships."

II. LITERATURE REVIEW

A) Safety Behavior

The term safety behavior, according to He et al. (2019), is an activity carried out by individuals in an entity related to safety. Safety behavior is the term used to describe worker safety activities in the workplace, which are demonstrated by worker actions aimed at enhancing safety at work (Adi et al., 2021). Geller (2017) states that safety behavior can be seen in how a worker behaves in the workplace. Many studies propose a safety behavior model that distinguishes two dimensions and focuses on safety compliance and safety participation (Griffin & Neal, 2002; Shi, 2020; Xue et al., 2020; Hutchinson et al., 2022; Lyubykh et al., 2022). Safety compliance is a mandatory behavior related to compliance with work rules and regulations, such as the use of personal protective equipment (Griffin & Neal, 2006). However, voluntary involvement in safety activities and offering assistance to coworkers with safety concerns are examples of employee conduct that can contribute to the development of a safe workplace environment, even though it may not directly increase workplace safety (Shen et al., 2017).

B) Safety Knowledge

Safety knowledge refers to workers' understanding and awareness of how to do work safely, including knowledge of safety equipment, standard work procedures, health and safety in the workplace, and hazards and precautions to reduce these hazards (Fruhen et al., 2014). Research conducted by Beus et al. (2010) examined the relationship between safety leadership and worker attitudes towards safety-related behavior through safety motivation and safety knowledge. This study shows that safety leadership is significantly related to workers' safety knowledge. In addition, research conducted by Bashel (2021) states that safety leadership and safety knowledge have a positive relationship. Safety leadership affects motivation and safety knowledge, which in turn has an impact on safety behavior. In addition, safety leadership positively affects safety knowledge, which leads to improved safety performance and reduced accidents. Therefore, we propose the hypothesis below:

H1: Safety leadership positively and significantly correlates with safety knowledge.

The research conducted by Kao et al. (2019) examined the connection between safety conduct and safety knowledge, with the results showing that safety knowledge is positively correlated with safety behavior through the dimensions of safety compliance and safety participation. Research conducted by Bashel (2021) states that safety knowledge and safety behavior also have a positive relationship. Thus, we propose the following hypothesis:

H2: Safety knowledge has a positive and significant correlation with safety behavior.

C) Safety Leadership

According to Ordway Tead in Soeardi et al. (2022), leadership is a process carried out by a person to influence others to carry out something as well as possible. The success of a leader in influencing others is influenced by one's credibility (Hughes et al., 2018). Pater (2001) in Wu et al. (2016) state that One subsystem associated with leadership is safety leadership. The process of interaction between leaders and followers in which leaders can utilize their influence to accomplish safety goals within the context of organizations and individuals is known as safety leadership (Wu et al., 2016). Research conducted by Li et al. (2020) shows that safety leadership can influence safety behavior by guiding and influencing individuals or groups to achieve safety goals while carrying out tasks. Hence, we propose the following hypothesis:

H3: Safety leadership has a positive and significant correlation with safety behavior.

Figure 3 depicts the research model and all three hypotheses.

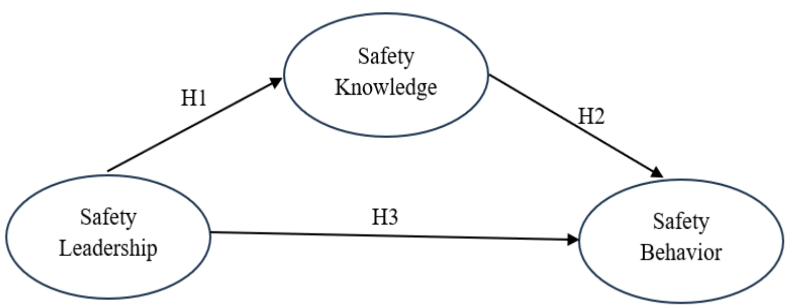

Figure 1. Research Model

III. RESEARCH METHODOLOGY

The method used in this research is quantitative, which involves distributing questionnaires to the population using cluster random sampling techniques. The population in this study is heavy equipment operators who work for contractors who provide services to mining companies. The company has different mine locations but is still led by the head of mine technical. The questionnaire distributed consists of Safety Leadership variables measured using standardized questionnaires and developed in accordance with the conditions of the study taken from the Senior Managers' Safety Leadership Scale (Xue et al., 2020) and Multifactor Leadership Questionnaire or MLQ (Avolio and Bass, 1995), Safety Knowledge measurement adopted modified from Guo et., al (2016) and Vinodkumar and Bhasi (2010), Safety behavior variables are measured using a standard questionnaire and developed according to the conditions of the study from Neal's scale (2000). This questionnaire uses a Likert scale ranging from 1 = strongly disagree to 5 = strongly agree.

The data were analyzed based on respondents' feedback using Partial Least Squares Structural Equation Modeling (PLS-SEM) technique and SmartPLS version 3 software. The next important stage in using SEM PLS analysis is evaluating the measurement model and structural model. By conducting thorough analyses of both the measurement and structural models, researchers can validate the measurement instruments, test theoretical hypotheses, and evaluate the overall model's explanatory and predictive capabilities in SEM studies.

IV. RESULTS AND DISCUSSION

A) Respondent Biography

The questionnaires were distributed within one month, and 347 respondents were collected, exceeding the minimum requirement of 291 samples calculated using the Slovin method. Respondents were workers from mining contractors located in several project areas, which were under the responsibility of the same Mine Technical Head. Most respondents were male, with 328 (94.5%). The age range of respondents is more at the age of 30-39 years, as many as 128 people (36.9%), 40-49 years, as many as 108 people (31.1%), 20-29 years, as many as 98 people (28.2%) and the rest are aged 50-59 years. Most of the respondents' education was graduated from high school as much as 82.7%, junior high school 10.4%, elementary school 2.6%, and the rest were diploma or bachelor's degree. The working period of respondents at the research site is divided into 3 groups, which are: less than 1 year as many as 115 people (33.1%), a range of 1-3 years as many as 113 people (32.6%), and more than 3 years as many as 119 people (34.3%). So, most respondents have a working period with placement at the research location for more than 3 years.

B) Measurement Model

The measurement model in structural equation modeling (SEM) assesses the relationships between latent constructs and each indicator. There are two stages to assess (Hair et al., 2022): the first is the reliability test, and the second is the validity test. Reliability is considered acceptable if the loading factor value for each indicator is > 0.708. Additionally, Cronbach's Alpha and Composite Reliability values should be > 0.7 but not exceed 1. Validity is seen from two aspects, namely convergence and discriminant. Convergent validity is evaluated using the Average Variance Extracted (AVE) statistic, where a value > 0.5 indicates good convergent validity. Discriminant validity is assessed by looking at the Heterotrait-Monotrait (HTMT) ratio; the maximum value does not exceed 0.9 for constructs that are conceptually very similar and 0.85 for constructs that are more different.

Table 1. Reliability Test and Convergence Test Result

Variable	Indicator	Reliability Test				Convergence Test
		Loading Factor	Cronbach's Alpha	Reliability (rho_A)	Composite Reliability	Average Variance Extracted (AVE)
Safety Behavior			0.92	0.92	0.93	0.67
	BHAV1	0.79				
	BHAV2	0.83				
	BHAV3	0.71				
	BHAV4	0.80				
	BHAV5	0.89				
	BHAV6	0.83				
	BHAV7	0.85				
Safety Knowledge			0.92	0.92	0.94	0.8
	KNOW1	0.89				
	KNOW2	0.90				
	KNOW3	0.90				
	KNOW4	0.89				
Safety Leadership			0.96	0.96	0.97	0.63
	SL10	0.82				
	SL11	0.86				
	SL12	0.79				
	SL13	0.83				
	SL14	0.84				
	SL15	0.79				
	SL16	0.84				
	SL17	0.85				
	SL18	0.86				
	SL2	0.72				
	SL3	0.76				

Variable	Indicator	Reliability Test				Convergence Test
		Loading Factor	Cronbach's Alpha	Reliability (rho_A)	Composite Reliability	Average Variance Extracted (AVE)
	SL4	0.76				
	SL5	0.79				
	SL6	0.73				
	SL7	0.70				
	SL8	0.76				

Table 2. Heterotrait-Monotrait (HTMT) Result

	Safety Behavior	Safety Knowledge
Safety Behavior		
Safety Knowledge	0.81	
Safety Leadership	0.75	0.7

The data resulting from processing using SMART PLS shows that the measurement model meets good criteria because the reliability and validity of the model align with the established criteria. However, we need to remove 2 measurement items (SL 1 and SL 9) from the safety leadership indicator due to factor loadings below 0.7.

C) Structural Model Analysis

The structural model analysis in SEM focuses on examining the relationships between latent constructs themselves. It investigates how one construct influences another directly or indirectly through a series of paths. Structural Model analysis can also examine the model's explanatory power. If the model has been measured and declared reliable and valid, then the structure test can be conducted. A hypothesis that assesses the relationship between constructs directly or indirectly can be seen from the p-value and t-value at the bootstrapping stage. At this stage, the researcher sets a significant number; in this study, a significant number of 5% and a one-tailed test are used. So, the relationship between variables will be accepted if the p-value <0.05 and the p-value>1.65 (for the one-tailed test). The explanatory power of the model is seen from the coefficient of the determinant (R2) with levels of 0.75 (substantial), 0.50 (moderate), and 0.25 (weak).

Table 3. R Square Result

	R Square	R Square Adjusted
Safety Behavior	0.64	0.64
Safety Knowledge	0.45	0.45

Based on Table 3, the R square for safety behavior is more than 0.5, but for safety knowledge, it is above 0.25 but under 0.50. So, the model made is classified as moderate.

Table 4. Direct Effect Result

	Original Sample (O)	T Statistics (|O/STDEV|)	P Values	Relevance
Safety Knowledge -> Safety Behavior	0.49	6.36	0.00	Yes
Safety Leadership -> Safety Behavior	0.38	5.14	0.00	Yes
Safety Leadership -> Safety Knowledge	0.67	13.19	0.00	Yes

The direct relationship between the variables tested in Table 3 shows that the variables have a significant effect, with p values <0.05 and t values >1.65 for all results. The direction of the relationship is also positive according to the numbers in the original sample column.

Table 5. Indirect Effect Result

	Original Sample (O)	T Statistics (|O/STDEV|)	P Values	Relevance
Safety Leadership -> Safety Knowledge -> Safety Behavior	0.33	6.47	0.00	Yes

The indirect relationship between the variables tested in Table 4 shows that the variables also have a significant effect, with p values <0.05 and t values >1.65 for all results. The direction of the relationship is also positive according to the numbers in the original sample column.

Based on the reliable and valid measurement instrument and structural model testing, it was concluded that all proposed hypotheses were supported with positive and significant effects. This study aligns with previous research findings. The tested and proven hypotheses in this research include: Safety leadership positively correlates with safety knowledge, safety knowledge positively correlates with safety behavior, and safety leadership positively correlates with safety behavior. Researchers also found that the mediating role of safety knowledge did not alter the direct relationship between safety leadership and safety behavior. Therefore, safety knowledge acts as a partial mediator.

V. CONCLUSION

Based on the results of hypothesis testing, it is evident that all three proposed hypotheses are supported. Safety leadership has a positive and significant correlation with safety knowledge, safety knowledge has a positive and significant correlation with safety behavior, and safety leadership has a positive and significant correlation with safety behavior. Interestingly, the influence of safety leadership by the Mine Technical Head remains unchanged even when considering the mediating variable of safety knowledge. These findings align with previous research that underscores the positive and significant impact of safety leadership on safety behavior.

To enhance the practical implications of this study, it would be beneficial in the future to disaggregate the assessment of safety leadership indicators into specific leadership dimensions. This approach would enable the Mine Technical Head (KTT) to formulate more targeted policies and programs by identifying which safety leadership dimensions exert the most significant influence on operator safety behavior within contractor organizations.

Interest Conflicts

The authors declare that there is no conflict of interest concerning the publishing of this paper.

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