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Analyzing the Influence of Safety Leadership, Work Pressure, and Safety Culture on Worker Safety Behavior in Steam Power Plant

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ABSTRACT

Workplace safety in coal-fired power plants in Sumatra, Indonesia, remains suboptimal, evident in the high incidence of work-related accidents leading to fatalities. This research acknowledges previous findings indicating that a significant portion of accidents is attributable to unsafe behavior. The aim of this study is to examine the combined impact of safety leadership, work pressure, safety culture, and safety behavior in a power plant in South Sumatra. Conducted at one of these facilities, the research utilized a questionnaire distributed to 102 respondents, with data analysis employing Structural Equation Modeling (SEM) through Partial Least Square (PLS). Results indicate that work pressure influences safety culture and safety behavior, safety leadership affects safety culture but insignificantly impacts safety behavior, and safety culture mediates the relationship between safety leadership, work pressure, and safety behavior. The implications of these findings provide guidance for companies to enhance safety behavior, emphasizing the establishment of a robust safety culture and effective safety leadership to prevent workplace accidents.

KEYWORDS: PLS-SEM, Safety Behavior, Safety Culture, Safety Leadership, Work Pressure

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1. INTRODUCTION

Workplace safety remains a critical concern for organizations worldwide, particularly in industries with inherently complex operations such as steam power plants. This research paper aims to comprehensively explore and understand the interconnected dynamics of safety leadership, work pressure, safety culture, and safety behavior in the context of a steam power plant (Strasser & Aaron, 1981). As the backbone of various sectors, including manufacturing, construction, and services, steam power plants play a pivotal role in sustaining societal functions (Baby et al., 2021). Despite the strategic importance of these facilities, the potential risks associated with their operations demand a meticulous examination of factors influencing safety outcomes.

Against the backdrop of Government Regulation No. 50 of 2012 on the Implementation of Occupational Safety and Health Management Systems, emphasizing the need to ensure and protect workers' well-being, this study delves into the specific challenges faced by steam power plants in maintaining a safe working environment (ILO, 2022). The incident analysis presented earlier serves as a real-world context, highlighting the imperative to address safety issues promptly (Heinrich et al., 1980). By scrutinizing data from the steam power plant incident and incorporating insights from existing literature, this research aims to bridge existing gaps in understanding the simultaneous influence of safety leadership, work pressure, safety culture, and safety behavior on overall safety performance (Fang et al., 2015).

With an increasing number of coal-fired power plants, such as the one under study, the research contributes to literature by focusing on the unique challenges posed by these facilities. The paper employs Structural Equation Modeling (SEM) based on Partial Least Squares (PLS) to quantify and analyze the intricate relationships among the key variables (Hair et al., 2017). The ultimate goal is to provide insights and recommendations to improve safety practices, mitigate workplace accidents, and enhance overall productivity in steam power plants. Through a nuanced exploration of safety dynamics, this research seeks to contribute valuable knowledge for the benefit of the steam power industry and occupational safety research as a whole (Xue et al., 2020).

2. LITERATURE REVIEW

Safety Behavior

(Heinrich & William, 1980) defines safety behavior as actions reflecting a sense of safety and health. (VandenBos, 2019) describes it as individual actions driven by awareness of disaster prevention and fear of consequences. The foundation of safety behavior includes regulations such as the 1970 Law requiring protective gear use. Researchers like (Fang et al., 2015) and (Neal & Griffin, 2006) define safety behavior as actions adhering to operational specifications or safety-oriented actions in daily work. (Heinrich & William, 1980) attributes approximately 88% of industrial accidents to unsafe behavior, emphasizing the importance of safety compliance and participation. The distinction between task performance (safety compliance) and contextual performance (safety participation) is discussed, emphasizing proactive safety actions and initiatives in maintaining workplace safety (Neal & Griffin, 2006).

Safety Culture

Safety culture, influenced by values, attitudes, perceptions, competencies, and behaviors, is defined by (ACSNI, 1993) and Indonesian labor regulations. (Silmi & Kurniawan, 2023) and Hale (2000) emphasize safety culture's impact on safety performance, risk response, and overall organizational activities. The three main components of safety culture—psychological, behavioral, and situational—are highlighted, measurable through qualitative and quantitative approaches. (Geller, 2001) stresses achieving a "total safety culture" through continuous attention to environmental, human, and behavioral factors. The "Safety Triad" concept is presented, emphasizing the strong interdependence of these factors. Safety culture, a holistic and long-term concept, significantly influences accident prevention and organizational performance. Improving safety culture positively affects overall organizational culture, promoting strong organizational commitment, efficient performance, and high productivity.

Safety Leadership

Safety leadership, as defined by (Wu et al., 2008) is how a leader influences team members to work together towards organizational safety goals, considering the organizational and individual situations. The objective of safety leadership is to establish a strong safety culture within the organization and ensure that all workers have a safe working environment. Ineffective safety leadership is often caused by a lack of understanding of the company's safety management systems and related policies, creating uncertainty about safety leadership responsibilities, accountability, and authority for making improvements (Cooper, 2015).

Work Pressure

Work pressure refers to the extent to which individuals perceive heavy demands in performing their tasks, leading to stress, anxiety, tension, or excessive mental pressure. It can result from high job demands, tight deadlines, or expectations for outstanding performance (Iverson & Maguire, 2000). Factors related to speed and workload are commonly known as work pressure and have the potential to negatively impact safety factors. This overlaps with themes like the balance between work schedule pressure and safety, recognized as a crucial component in safety culture (ACSNI, 1993; Mullen, 2004), cited by (Setyawan et al., 2021) noted that unsafe behavior among construction workers is not due to a lack of risk awareness but is a result of work pressure imposed by supervisors and managers.

Structural Equation Modeling (SEM)

Structural Equation Modeling (SEM) serves as a data analysis tool for investigating comprehensive relationships among variables in research (Santoso, 2011). It is a multivariate analysis method involving the interconnection of several exogenous latent variables (independent variables) and endogenous latent variables (dependent variables) to form a model (Kline, 1998). Research employing SEM is confirmatory in nature, where the method is utilized to test hypotheses derived from existing theories and concepts. SEM enables the modeling of intricate relationships among variables that are typically not directly measurable but are assessed indirectly through several indicator variables (Hair et al., 2017). SEM is used to examine a theoretical framework from a predictive perspective, aiming to better understand increasing complexity. It serves as exploratory research for theory development, utilizing Structural Equation Modeling (SEM) based on Partial Least Squares (PLS).

3. METHODS

The research methodology adopts a descriptive approach, employing a quantitative design and Structural Equation Modeling (SEM) to systematically depict characteristics. It follows a cross-sectional data collection method within a descriptive research framework. The process begins with an extensive literature review to establish theoretical foundations. A carefully crafted questionnaire, utilizing a Likert scale (1-5) for assessment, is distributed to power plant workers. The sample size is determined through G*Power, and it has been established that a minimum of 77 participants is necessary.

The subsequent phase involves testing the Measurement Model and Structural Model using PLS-SEM. In the Measurement Model, convergent validity assesses loading factor, while discriminant validity examines fornell-larcker and cross-loading factors. Additionally, reliability is evaluated through measures like Cronbach’s alpha, composite reliability, and Average Variance Extracted (AVE). Moving to the Structural Model, R^2 is employed to measure the influence of independent variables on dependent variables, and f^2 assesses the effect size. Q^2 is used to evaluate predictive relevance, and T-statistics, along with p-values, test the significance of hypotheses.

4. RESULTS

In the measurement model test, reflective measurement is employed, comprising loading factor, composite reliability, Cronbach's alpha, and Average Variance Extracted (AVE) assessments. Additionally, discriminant validity is evaluated through Fornell-Larcker criteria and cross loading. The overall values of the measurement model test are presented in Table 1.

TABLE 1. Measurement Model

Variable	Indicator	Outer Loading (>0,7)	Cronbach's Alpha (>0,6)	Composite Reliability (>0,7)	AVE (>0.5)	Forner-Larcker Criterion
Safety Behavior	SB1	0.888	0.924	0.940	0.724	0.851
	SB2	0.831				
	SB3	0.861				
	SB4	0.820				
	SB5	0.845				

Variable	Indicator	Outer Loading (>0,7)	Cronbach's Alpha (>0,6)	Composite Reliability (>0,7)	AVE (>0.5)	Forner-Larcker Criterion
	SB6	0.860				
Safety Culture	SC1	0.903	0.945	0.956	0.786	0.886
	SC2	0.873				
	SC3	0.854				
	SC4	0.903				
	SC5	0.910				
	SC6	0.874				
Safety Leadership	SL1	0.898	0.910	0.933	0.737	0.859
	SL2	0.860				
	SL3	0.798				
	SL4	0.892				
	SL5	0.841				
Work Pressure	WP1	0.887	0.957	0.964	0.769	0.877
	WP2	0.896				
	WP3	0.842				
	WP4	0.841				
	WP5	0.899				
	WP6	0.912				
	WP7	0.884				
	WP8	0.850				

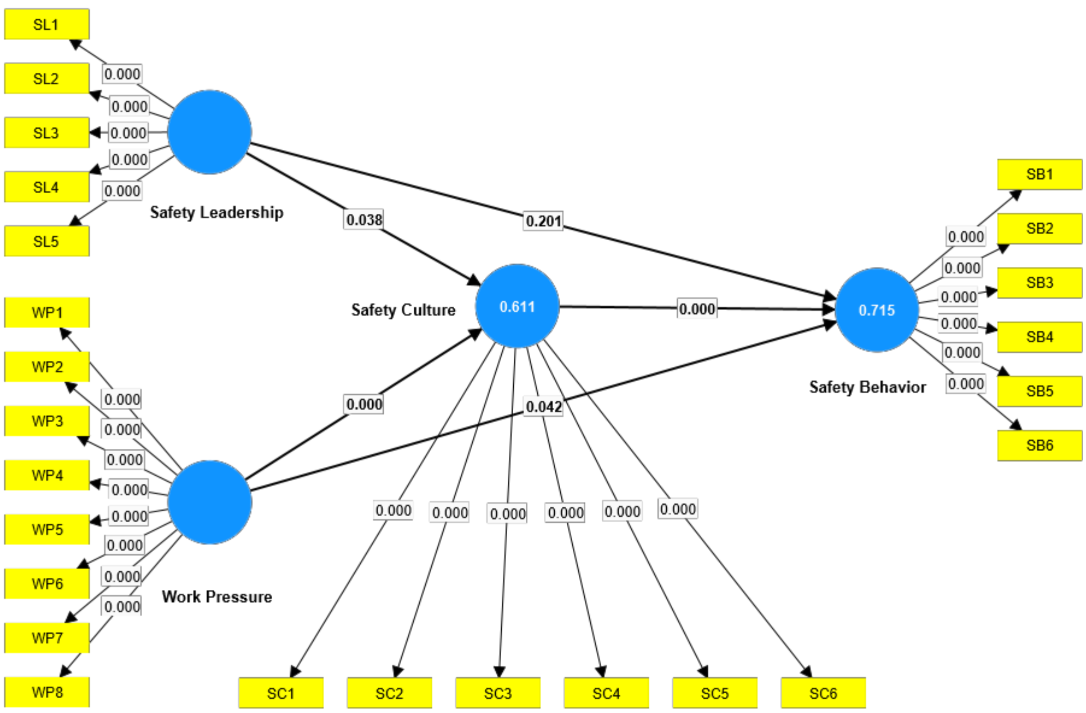
As observed in Table 1, all rule of thumb criteria for the measurement model test have been satisfied, indicating that the model in this study is both valid and reliable. The lowest outer loading values are observed for the safety leadership variable SL3 (0.798), specifically concerning "My senior manager encourages employees to report potential incidents without punishment." The lowest outer loading for the work pressure variable is associated with WP4 (0.841), addressing "The current number of employees is sufficient to perform the job." In the case of the safety culture variable, SC3 (0.854) has the lowest outer loading, pertaining to "Operational work cessation can be done if safety and security are not guaranteed." Lastly, for the safety behavior variable, SB4 (0.820) exhibits the lowest outer loading, related to "I use all necessary safety equipment to perform my job."

The subsequent stage involves conducting a structural model test. The criteria utilized for assessing the structural model in this research encompass R-square (R^2), F-square (F2), Mediation Effect Size Upsilon (v), Predictive Relevance (Q2), Path Coefficient (β), and t-test employing the bootstrapping method. The comprehensive results of the structural model test are available in Table 2.

TABLE 2. Structural Model

Hypothesis	Path	Path Coefficient	T- statistics	P- value	F- square	Results	
						P-value	Effect Size
H1	SC -> SB	0.549	4.864	0.000	0.411	Significant	Large
H2	SL -> SB	0.145	1.280	0.201	0.032	Insignificant	Small
H3	SL -> SC	0.286	2.070	0.038	0.101	Significant	Moderate
H4	WP -> SB	0.225	2.032	0.042	0.062	Significant	Small
H5	WP -> SC	0.550	4.054	0.000	0.374	Significant	Large
H6	SL -> SC -> SB	0.157	1.999	0.046	0.025	Significant	Small
H7	WP -> SC -> SB	0.302	2.837	0.005	0.091	Significant	Moderate

Based on Table 2, it is evident that 6 hypotheses are accepted, while 1 hypothesis is rejected. Safety Culture (SC) has a significant impact on Safety Behavior (SB). However, Safety Leadership (SL) does not have a significant influence on Safety Behavior (SB). Safety Leadership (SL) significantly affects Safety Culture (SC). Work Pressure (WP) has a significant impact on both Safety Behavior (SB) and Safety Culture (SC). Safety Culture (SC) acts as a mediator between Safety Leadership (SL) and Safety Behavior (SB), as well as between Work Pressure (WP) and Safety Behavior (SB). The model illustrating the path coefficients can be observed in Figure 1.



Source: SmartPLS

FIGURE 1. Path Coefficient

TABLE 3. R-Square

Variable	R-square	R-square adjusted	Results
Safety Behavior	SB1	0.888	0.924

As seen in Table 3, the R-square value is 0.706, indicating that 70.6% of the variability in safety behavior can be explained by the predictor variables in the model, namely safety leadership, work pressure, and safety culture. The remaining 29.4% is influenced by other variables outside the model.

TABLE 4. Model Fit Test

Sub-criteria Analysis	Rule of Thumb	Saturated model	Estimated model	Results
SRMR	< 0.10	0.047	0.047	Fit
NFI	> 0.90	0.828	0.828	Marginal

As seen in Table 4, the Standardized Root Mean Square Residual (SRMR) value is 0.047 (<0.10), indicating that the model in this study can be considered a good fit (Hanseler, 2011). The Normed Fit Index (NFI) is 0.828, where the NFI value in this study is smaller than the rule of thumb (>0.90). However, the closer the NFI value is to 1, the better the model. Considering the NFI value obtained, the model in this study can be considered marginally fitting as the NFI is less than 0.90.

5. CONCLUSIONS

The research findings elucidate the interrelationships among safety leadership, work pressure, safety culture, and safety behavior in a power plant setting. The analysis results indicate that safety culture serves as a central element influencing safety behavior in the workplace, with both being significantly influenced by safety leadership. Safety leadership, encompassing policies, communication, and actions supporting a safety culture, emerges as the primary driver in shaping safety culture. Leadership that prioritizes safety values and consistently supports safety practices can establish safety norms and expectations throughout the organization. Therefore, safety leadership plays a crucial role in creating a foundation for a robust safety culture. Conversely, a strong safety culture provides the groundwork for the development of positive safety behavior among organizational members. Consistent application of safety culture can create norms and values that encourage individuals to adopt safe practices. Individuals are inclined to participate in safety practices, adhere to policies, and support each other to create a safe working environment. In conclusion, it can be inferred that the relationship between safety culture, safety behavior, and safety leadership is interrelated and mutually influential. Safety leadership takes a primary role in shaping safety culture, which, in turn, forms norms and safety behaviors throughout the organization.

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