KESANS: International Journal of Health and Science
2808-7178 / 2808-7380
http://kesans.rifainstitute.com/index.php/kesans/index

Analysis of Work Safety Climate on Workers' Safe Work Behavior in the Geothermal Drilling Industry PT. XYZ, 2026

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Article Information
Submitted: **11 August 2026**
Accepted: **19 August 2026**
Publish: **24 August 2026**

Keyword: Work Safety Climate; Safe Behavior; NOSACQ-50; Occupational Health and Safety (OHS); Geothermal Drilling;

Abstract
Introduction: *The geothermal drilling industry has a high work risk so a safety climate is needed that is able to encourage the safe behavior of workers.* ***Objective:*** *This study aims to analyze the perception of the work safety climate based on the seven dimensions of NOSACQ-50, the level of safe behavior, and the relationship between the two in workers of PT. XYZ.* ***Methods:*** *Quantitative research with cross-sectional design involved 120 workers through total sampling. Data were collected using structured questionnaires and analyzed univariately, bivariate using Fisher's Exact Test, and multivariate using linear regression.* ***Result and Discussion:*** *The majority of workers have a moderate safety climate of 69.2%. The safety climate was significantly associated with safe behavior (p=0.001), with R^2 0.883. On the seven-dimensional model, the R^2 reaches 0.890. The dimension of safety priority and intolerance of hazard risk became the dominant predictors, followed by confidence in the effectiveness of the OHS system and workers' commitment to safety.* ***Conclusion:*** *These findings confirm the importance of strengthening safety priorities, the reliability of OHS systems, and workers' commitment to improving safe behaviors*

How to Cite: **Gilang Arya Ramadhan, Nurulia Hidayah/Analysis of Work Safety Climate on Workers' Safe Work Behavior in the Geothermal Drilling Industry PT. XYZ, 2026/Vol. 5, No. 11, 2026**
DOI: https://doi.org/10.54543/kesans.v5i11.718
e-ISSN/p-ISSN: **2808-7178 / 2808-7380**
Published by: **CV. Rifainstitut/KESANS: International Journal of Health and Science**

Introduction

The geothermal energy industry sector in Indonesia is experiencing rapid growth in response to the increasing national energy demand (Istiqamah et al., 2023). The characteristics of this industry are classified as capital-intensive and high-tech (high cost, high tech), while at the same time harboring an extreme level of danger (high risk), every operational stage, from initial surveying, drilling (drilling), to power plant management, is vulnerable to fatal incidents such as severe fires and H_2S toxic gas leaks (Gunawan et al., 2021); (Harefa & Harmoko, 2021). The readiness of competent human resources in the aspect of Occupational Safety and Health (OHS) is an absolute prerequisite for this industry to be able to compete globally while minimizing the risk of work accidents (Setiawan et al., 2026).

The complexity of this risk is illustrated by data from the Ministry of Energy and Mineral Resources which recorded 438 incidents of work accidents in this sector during the 2014-2024 period, with 86 people died. Especially in 2024, the drilling sub-sector accounted for 82 incidents with details of 1 fatality, 18 serious injuries, 25 moderate injuries, and 38 minor injuries, of which around 85% of the accidents actually hit support service companies or rig contractors (Energy, 2021). This condition indicates that occupational safety awareness and qualifications in the scope of work of third parties still need serious strengthening.

The modern occupational safety perspective views work accidents not as unavoidable coincidences, but rather as the result of a series of factors that can be identified and mitigated (Mayansara et al., 2025). The UK Health and Safety Executive (HSE UK, 2021) reports that 90% of workplace injuries are caused by the personal actions of the operator, while a systematic literature review by Jamil Zara et al. (2023) confirms that unsafe acts contribute to 80–95% of all workplace accidents. In line with that, Ifka W. Kobis et al. (2025) proved that there is a positive correlation between the formation of safe behavior and a decrease in the number of work fatalities. The formation of safe behavior itself does not arise independently. Sadullah and Kanten (2021) and Mahdinia et al. (2022) show that the organizational climate is the main determinant behind the birth of safe actions in high-risk work environments.

The safety climate is part of the organizational climate that describes how workers view the importance of safety in the workplace. The safety climate has an important role in shaping safe work habits and culture (Rahma et al., 2025); (Martviyori & Lubis, 2022). The importance of this aspect can be seen from the various major industrial accidents, such as Piper Alpha and Chernobyl, which show that weak safety management and low attention to safety can lead to serious work system failures. Conceptually, the work safety climate is related to employees' perception of the safety policies, regulations, and practices implemented in the workplace. The better a worker's perception of safety, the more likely they are to comply with applicable safety standards and procedures (Khairaningsih & Sobirin, 2022). This is also supported by research by Wulandari et al. (2024) which shows that a good perception of a safety climate can encourage workers to behave safely and increase job satisfaction. Conversely, inappropriate understanding or perception of occupational safety and health (OHS) can encourage the emergence of unsafe behaviors and increase the risk of work accidents (Sukma Ayu Raganingtyas et al., 2025); (Untari et al., 2021)

PT. XYZ is a company that provides integrated drilling, workover, and project management services in the oil and gas and geothermal energy sectors. As a company that has high-risk work activities, PT. XYZ also faces various challenges in maintaining the safety of its workers. Based on the results of the company's internal investigation into work accidents during 2024, as many as 70% of accidents are known to be related to unsafe behavior. These behaviors include violating work procedures, putting limbs in dangerous positions, lack of communication between team members, and not implementing Job Safety Analysis (JSA) properly.

The management of PT. XYZ has actually made various efforts to improve work safety. These efforts include providing education about OHS procedures, holding regular safety meetings, installing warning signs, organizing training, and giving awards to workers. In addition, the company has also implemented various safety systems such as permits to work, JSA, HIRARC, and hazard reporting programs. However, these programs focus more on technical and operational hazard control. Meanwhile, factors related to the way workers view and feel safety conditions in the workplace have not been systematically studied. In fact, workers' perceptions of safety can affect the way they behave and behave when facing risks in the workplace. The purpose of this study is to analyze workers' perceptions of the work safety climate at PT. XYZ is based on the seven dimensions of NOSACQ-50, analyzing the level of safe behavior of drilling rig workers that includes compliance and participation in work safety, as well as analyzing the relationship between the work safety climate and the safe behavior of workers. This study also aims to find out how much the relationship between the work safety climate and safe behavior can be the basis for determining safety aspects that need to be strengthened in drilling activities at PT. XYZ.

Method

This study uses a quantitative analytical approach with a cross-sectional design to analyze the relationship between the occupational safety climate and the safety behavior of workers. The research was carried out at PT. XYZ, the Mount Salak Geothermal Project, in the January-March 2026 period. The research population consists of all workers who are on duty in the area of the geothermal drilling rig of PT. XYZ, including the workers of the subcontractor company, with a total of 120 people. The sampling technique uses saturated sampling or total sampling, so that the entire population is used as a research respondent. The characteristics of the respondents collected included age, last level of education, and length of service. The main independent variable is the work safety climate, while the dependent variable is the safe behavior of workers

Data collection was carried out through structured interviews using questionnaires. Occupational safety climate was measured using an instrument adapted from the Nordic Occupational Safety Climate Questionnaire (NOSACQ-50) which consisted of 50 statements, including 29 favorable statements and 21 unfavorable statements. The measurement includes seven dimensions, namely management's commitment and ability in occupational safety, management empowerment, management fairness, worker commitment to safety, worker safety priority and intolerance of hazard risks, learning-communication-trust, and trust in the effectiveness of the OHS system. The assessment uses a four-level Likert scale and the total results are categorized into good, moderate, and poor. Safe behavior was measured using a questionnaire consisting of 10 statements, namely seven favorable statements and three unfavorable statements, with always, sometimes, and never-ending answer options. The total score of safe behavior was then

categorized into good, moderate, and poor according to the criteria that had been set in the study

Data analysis was carried out in stages through univariate, bivariate, and multivariate analysis. Univariate analysis was used to describe the distribution of respondent characteristics as well as the categories of work safety and safe behavior climate in the form of frequency and percentage. Bivariate analysis was used to test the relationship between age, education level, working life, and work safety climate with safe behavior using the Chi-Square test; if there are cells with an expected count value of less than 5, Fisher's Exact Test is used as an alternative test, with a statistical significance level of $p<0.05$. Multivariate analysis was performed using simple linear regression to assess the relationship between the overall score of the occupational safety climate and safe behavior and multiple linear regression to analyze the contribution of the seven dimensions of the work safety climate simultaneously. Before multiple regression is interpreted, linearity and multicollinearity tests are performed using Tolerance and Variance Inflation Factor (VIF) values. The magnitude of the ability of independent variables to explain safe behavior variation is assessed using the determination coefficient (R^2). The entire research process pays attention to the principles of informed consent, confidentiality and anonymity of respondents, non-exploitation, and researcher neutrality

Results and Discussion

1. Results

Characteristics of Respondents and Work Safety Climate

The study involved 120 workers of the geothermal drilling rig of PT. XYZ. Most of the respondents were ≥30 years old (68 people; 56.7%), had a secondary education/high school-vocational school (74 people; 61.7%), and had a working period of >1 year (97 people; 80.8%). Safe behavior was most in the medium category, which was 63 workers (52.5%), followed by the good category of 50 workers (41.7%) and less than 7 workers (5.8%). The distribution of the occupational safety climate is presented in Table 1.

Table 1
A Description of the Work Safety of Workers. XYZ Year 2026

No.	Work Safety Climate	Quantity (n)	Percentage (%)
1	Good	36	30.0
2	Moderate	83	69.2
3	Poor	1	0.8
	Total	**120**	**100.0**

Source: Research data of PT. XYZ, 2026.

Results of Bivariate Analysis

The Fisher's Exact Test showed that age was not significantly associated with safe behavior ($p=0.494$), nor was length of service ($p=0.448$). In contrast, education level was significantly related to safe behavior ($p=0.001$). The strongest relationship in the categorical analysis was found between the work safety climate and safe behavior ($p=0.001$). All workers with a good safety climate perception showed good safe behavior, while one worker with a low safety climate perception was in the low safe behavior category.

Results of The Regression of the Work Safety Climate to Safe Behavior

Simple linear regression showed a positive and significant relationship between the work safety climate score and the safe behavior score. An R^2 value of 0.883 indicates that in this study model, 88.3% of the variation in the safe behavior score can be explained by the work safety climate score, while the remaining 11.7% are related to other factors outside the model. A summary of the model is shown in Table 2.

Table 2
Simple Linear Regression of Work Safety Climate to Safe Behavior

Models	Estimate	R^2	p-value
Intercept	-6.984	0.883	<0.001
Work Safety Climate	0.208		

Source: Research data of PT. XYZ, 2026.

Regression Results of the Seven Dimensions of the Work Safety Climate

The multiple linear regression model yields R^2=0.890. Of the seven dimensions of NOSACQ-50 analyzed, three dimensions had a significant effect on safe behavior, namely workers' commitment to safety (β=0.1286; p=0.049), worker safety priorities and intolerance of hazard risks (β=0.3808; p<0.001), and confidence in the effectiveness of the OHS system (β=0.1887; p=0.006). The dimensions of safety priority and risk denial have the largest standardized beta making them the dominant predictors in the model.

Table 3
Regression of the Seven Dimensions of the Work Safety Climate to Safe Behavior

Dimensions of Work Safety Climate	B	β	t	p
Commitment & management ability	0.1024	0.0737	1.03	0.304
Management empowerment	0.2044	0.0759	1.42	0.159
Management fairness	0.0855	0.0796	1.06	0.290
Employee commitment	0.4353	0.1286	1.99	0.049*
Safety prioritization & risk denial	0.3171	0.3808	3.96	<0.001**
Learning, communication & trust	0.1128	0.1015	1.07	0.288
Confidence in the effectiveness of the OHS system	0.3906	0.1887	2.82	0.006**

** significant; ** very significant according to the markings on the manuscript.*

2. Discussion

Employee Profile and Safety Climate Level

The predominance of workers aged ≥30 years and a working period of >1 year indicates that the study population is relatively experienced in rig operations. However, as many as 69.2% of workers still assess the safety climate in the medium category. This pattern suggests that work experience is not automatically followed by a very positive perception of the safety system. Conceptually, the safety climate is the collective perception of workers towards organizational safety priorities, policies, procedures, and practices (Zohar, 1980; Neal & Griffin, 2004). Therefore, the dominance of the medium

category can be read as a room for improvement in the consistency of OHS implementation, management involvement, risk communication, and workers' confidence in the safety system.

Age, Education, and Working Years For Safe Behavior

The absence of a significant relationship between age (p=0.494) and working time (p=0.448) suggests that safe behavior in the drilling environment is not adequately explained by maturity, age, or length of experience. The age findings are in line with Aditya's (2021) study on oil and gas drilling workers, while the employment outcomes are in line with the findings cited in the paper that longer experience does not necessarily result in better safety compliance. In high-risk jobs, experience can even go hand in hand with the process of adapting to hazards if repeated risks are considered a normal part of the job. In contrast, education level was significantly associated with safe behavior (p=0.001), but the distribution in the cross-table showed a not entirely linear pattern: highly educated workers were more likely to be in the safe behavior category, but the proportion of the less category was also greater than that of the secondary education group. Therefore, these results are more accurately interpreted as differences in safe behavior patterns according to education levels, not as evidence that improving education levels always results in safer behaviors. These findings still support the needs of OHS education that are tailored to the characteristics of workers and the work context. However, the relationships found need to be understood in the context of cross-sectional design, so it cannot be ensured that education levels directly result in safe behavior changes. Other factors that are not measured, such as the type of task, hazard exposure, level of responsibility, OHS training, or organizational characteristics, can also contribute to the pattern of the relationship

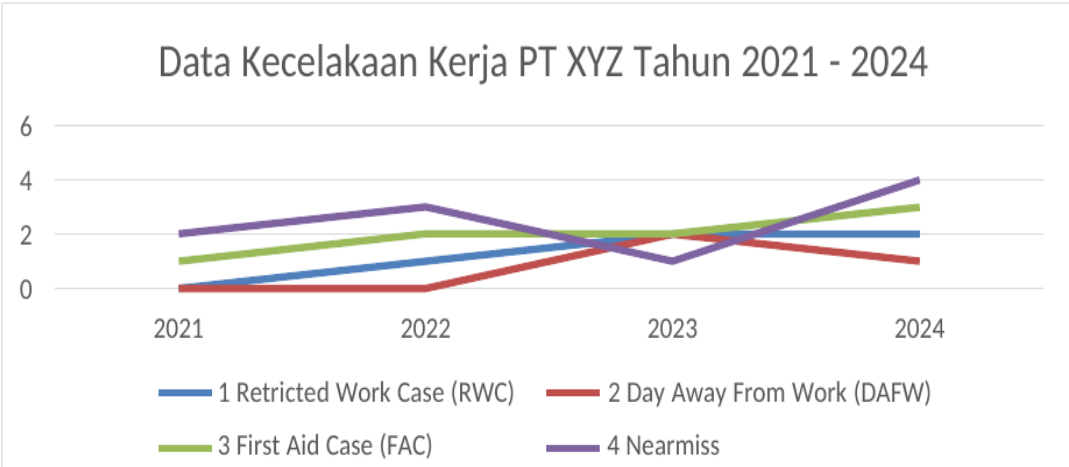

Figure 1. Data on Geothermal Drilling Rig Work Accident of PT. XYZ Year 2021–2024

Source: Department of QHSE Geothermal Drilling Rig PT. XYZ.

The Climate of Occupational Safety as a Determinant of Safe Behavior

The significant relationship between safety climate and safe behavior in bivariate analysis (p=0.001), as well as R^2=0.883 in simple regression, showed that workers' perception of safety had a very strong correlation with safety behavior in the study sample. Nonetheless, the R^2 value of 0.883 needs to be interpreted carefully. The score

suggests that the model is able to explain most of the variation in safe behaviors in the study data, but it does not mean that the safety climate causally determines 88.3% of workers' safe behavior. The magnitude of the determination coefficient can also be influenced by the design characteristics and measurement methods of the research.

These results are in line with Neal and Griffin (2004) who placed safety climate as a contextual factor that influences safety motivation and performance, and Prihatiningsih and Sugianto (2021) who reported that safety climate is related to compliance with safety regulations. In the context of PT. XYZ, the mechanism can be seen through the use of PPE, participation in rig safety meetings, toolbox meetings, permits to work, Job Safety Analysis, and the implementation of Stop Work Authority. Methodologically, measurements of safety climate and safe behavior conducted in the same period and sourced from the same respondents have the potential to cause same-source bias or common method bias. Respondents' positive perceptions of the safety environment can go hand in hand with the tendency to give a positive assessment of their own safety behavior, so that the strength of the relationship between variables has the potential to be higher than if safe behavior is assessed through independent observation or objective data. In addition, perception-based measurement can also be influenced by social desirability bias, especially in the context of occupational safety when respondents know that OHS-compliant behavior is organizationally expected behavior. Therefore, the high R^2 needs to be read as an association strength in the sample and measurement method of this study, not as an absolute estimate of the magnitude of the influence of safety climate on all operational conditions.

Figure 1 shows that RWC, DAFW, FAC, and near miss incidents continue to appear in the 2021–2024 period. The historical data is not the main output of the 2026 study, but it provides operational context that strengthening safe behaviors remains relevant even though the company already has an OHS program. The manuscript also notes that there is a perception that dangerous actions are sometimes still tolerated when the workload is high. This condition reflects a possible rhetoric-reality gap, which is the difference between formal safety messages and the reality that workers feel at a time when operational pressures are increasing. The existence of historical incident data also shows the importance of not equating high perception scores or strong statistical relationships with actual safety success. The perception of the safety climate and safe behavior still needs to be compared with objective indicators, such as the results of behavioral observations, procedural violations, audit findings, near misses, and work accidents, to obtain a more comprehensive picture of safety performance.

Dominant Dimensions: Safety Priority, Worker Commitment, and Effectiveness of the OHS System

Seven-dimensional regression showed that worker safety priority and intolerance of hazard risk were the most dominant predictors ($\beta=0.3808$; $p<0.001$). Scientifically, these results are logical because rig work demands quick decisions in high-risk conditions; Safe behavior is more likely to emerge when workers resist shortcuts, don't sacrifice safety for the sake of the target, and are willing to stop work when hazard control is inadequate. Conversely, repeated exposure to dangerous situations can increase risk acceptance and encourage the normalization of deviance as described by Vaughan (1996), or drift into failure according to Dekker (2011). Workers' commitment to safety was also significant ($\beta=0.1286$; $p=0.049$), which shows the importance of internalizing safety values at the individual and group levels. The script depicts workers reminding each other

of the use of PPE, participating in toolbox meetings, and viewing safety as a shared responsibility.

However, strong commitment at the group level that is not always followed by an equal perception of management commitment can form a climate of safety imbalance between organizational levels (climate strength asymmetry). Confidence in the effectiveness of the OHS system was the second significant predictor (β=0.1887; p=0.006). The existence of permits to work, JSA, safety induction, routine inspections, hazard observation, equipment maintenance, and Stop Work Authority form workers' belief that the organization's systems are truly capable of controlling hazards. However, the manuscript shows that trust in safety audits is relatively lower than in educational programs. This emphasizes that audits need to be accompanied by visible follow-up and communication of improvement results to workers so that the function of the safety system is perceived as real, not just administrative.

Interpretation of the magnitude of the coefficients of each dimension also needs to consider that the seven dimensions of safety climate are conceptually part of an interconnected construct. Therefore, when all dimensions are incorporated simultaneously into the model, the individual contribution of a dimension can be smaller or insignificant even though it remains substantively relevant. Thus, statistically insignificant dimensions should not be immediately considered unimportant for safety management, but rather need to be understood in terms of their position and relationship to other dimensions in the overall safety climate system

Position and Contribution of Findings

Overall, the research answers the formulation of the problem by showing that the safety climate is closely related to safe behavior, but the contribution of each dimension is not the same. Three significant dimensions provide the basis for priority interventions: strengthening the principles of safety first and Stop Work Authority, increasing the internalization of safety commitments to workers, and ensuring that each OHS system delivers tangible and reliable results. The other four dimensions remain positive but not significant individually after being analyzed together. Because the research design is cross-sectional, a high R^2 value should be understood as the model's explanatory ability in the research data, not as evidence of temporal causality. In addition to not being able to ensure the sequence of time between the safety climate and safe behavior, the design also opens up the possibility of a reverse relationship, that is, workers who already have good safety behavior can assess the safety climate of their organization more positively. The observed relationships can also be influenced by other variables that have not been included in the model. Therefore, the use of the term "determinant" in this study is more accurately understood in the sense of statistical predictors in the research data and not causal determinants that have been proven longitudinally or experimentally.

The very high R^2 value of 0.883 reinforces the need for caution. In addition to possibly reflecting a strong substantive relationship between safety climate and safe behavior, this value can be influenced by the similarity of data sources, the same measurement time, the similarity of the response context, and the conceptual proximity between perceptions of safety practices and reporting of safety behaviors. Because this study has not used behavioral measurements from independent sources or longitudinal designs, the model's ability to explain the data cannot be directly generalized as the magnitude of the actual effect on the population of other rig workers or on different operational periods. The next study needs to combine questionnaires with behavioral

observations, incident and near miss data, audit results, or supervisory assessments, and conduct longitudinal measurements to test the stability and direction of the relationship between variables. Thus, the main contribution of this study is to provide applied empirical evidence regarding the NOSACQ-50 profile and safe behavior in the geothermal drilling operations of PT. XYZ as well as identify the most strategic safety dimensions to act on. However, such contributions are mainly applicable to the context of the sample and the measurement conditions of this study. The findings should be used as a basis for mapping improvement priorities and hypothesis formation for future research, not as final evidence that climate change in safety will directly result in a significant change in safe behavior as shown by the regression model

Conclusion

The work safety climate has a significant and strong relationship with the safe behavior of workers in the geothermal drilling industry of PT. XYZ. The majority of workers still perceive the work safety climate in the moderate category (69.2%), which shows that there is still room to strengthen the implementation and perception of safety in the work environment. Among the characteristics of individuals, education shows a relationship with safe behavior, whereas age and working age do not show a meaningful relationship. Further analysis showed that the dimensions that play the most role in explaining safe behavior are the priority of worker safety and the intolerance of hazard risks, confidence in the effectiveness of the OHS system, and the commitment of workers to safety. These findings confirm that efforts to improve safe behavior need to be focused on strengthening safety principles as a top priority amid operational demands, increasing worker confidence in the implementation of the OHS system, and strengthening safety commitments at the individual and group levels. Thus, this study provides an empirical basis for the determination of safety intervention priorities in the geothermal drilling operations of PT. XYZ without repeating in detail the statistical results that have been presented in the results section

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