International Journal of Safety and Security Engineering
Vol. 15, No. 1, January, 2025, pp. 31-42
Journal homepage: http://iieta.org/journals/ijsse

Influence of Safety Leadership Styles on Safety Behaviour: The Mediating Role of Safety Climate, Knowledge, and Motivation in Indonesia's Oil and Gas Construction Project

Novrianty Rizky[1], Agus Mansur[1*], Hari Purnomo[1], Adithya Sudiarno[2], Ivan Darma Wangsa[2]

[1] Department of Industrial Engineering, Faculty of Industrial Technology, Universitas Islam Indonesia, Yogyakarta 55584, Indonesia
[2] Department of Industrial and Systems Engineering, Institut Teknologi Sepuluh Nopember, Surabaya 60111, Indonesia

Corresponding Author Email: agusmansur@uii.ac.id

Copyright: ©2025 The authors. This article is published by IIETA and is licensed under the CC BY 4.0 license (http://creativecommons.org/licenses/by/4.0/).

https://doi.org/10.18280/ijsse.150104

Received: 26 August 2024
Revised: 23 November 2024
Accepted: 12 December 2024
Available online: 31 January 2025

Keywords:
safety leadership, safety program, safety climate, safety knowledge, safety motivation, safety behavior, mediated variable, oil and gas project

ABSTRACT

Workplace injuries in the mining, oil, gas, and construction sectors in developing countries continue to increase. These work accidents occur because worker safety behaviors are low. Oil and gas construction projects in Indonesia are increasing because the capacity of oil and gas refineries is raised to meet the national demand for fuel oil. As such, occupational accidents at one of the construction projects in Indonesia have also increased. This study examines how worker safety behaviors are impacted by safety programs and transformational and transactional leadership styles. In addition, several mediation variables of the impact of leadership styles on safety behavior variables were also analyzed, including safety climate, knowledge, and motivation. The hypothesis was proposed using twenty-two direct and indirect tests with 675 workers as respondents. This study uses the structural equation modeling method for the tests. The results show that several hypothesis tests were accepted and there was positive relationship between variables, such as the relationship between safety climate and safety knowledge, as well as safety knowledge and safety behavior. These findings provide insight for HSE managers to provide examples of safety climate in the oil and gas construction projects.

1. INTRODUCTION

Implementing occupational safety and health (OSH) in projects and industries is a vital aspect that all industries' management must pay attention to. The International Labor Organization [1] estimated that every year, there are 2.78 million workers who experience work accidents leading to death or work-related illnesses. In addition, more than 374 million people were injured due to work accidents. In addition, data shows that most accidents occur in developing countries in certain occupational fields, such as mining, oil and gas, fisheries, and construction. Construction companies have more workers who experience work accidents. Jobs in the high-risk category include working at heights, digging, working in confined spaces, and lifting heavy objects. These jobs often have fatal consequences and can result in the victim being permanently disabled or dead.

Oil and gas are also sectors prone to accidents. The number of instances in Indonesia has increased since the government's national strategic goals include the development of oil and gas refineries. This development, with a total investment of $48 billion, will answer several future challenges, including meeting the increasing demand for fuel (fuel processing capacity in 2030 will reach 1.8 million barrels per day) and producing high-quality fuel products environmentally friendly from Euro II to Euro V. As such, accidents at oil and gas projects in Indonesia are increasing due to the progress of work and the number of workers. From 2019 to 2022, the oil and gas construction project recorded 181 work accidents, with 78 near misses and 42 incidents of property damage.

According to the Social Security Administrator for Employment [2, 3]. As indicated in Figure 1, the frequency of accidents in Indonesia rose by 3 to 28% between 2010 and 2023. Meanwhile, construction-related incidents make up over 32.0% of all accidents across all sectors, with industry and transportation coming in second and third, respectively, as seen in Figure 2.

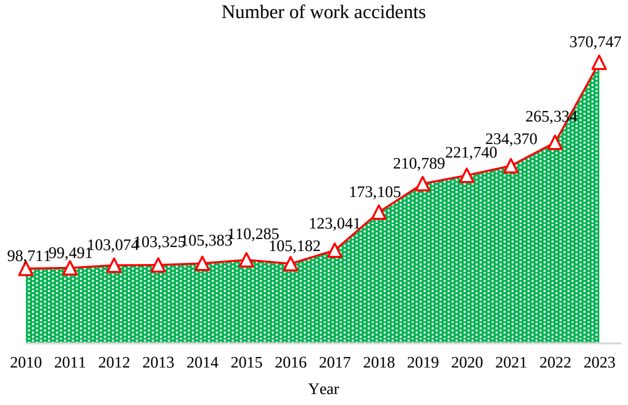

Figure 1. Number of worker accidents in Indonesia [2]

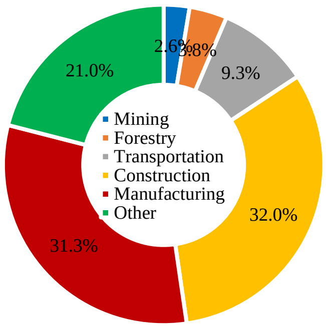

Figure 2. Percentage of accidents in all sectors in Indonesia [2]

Kavianian and Wentz [4] explained that work accidents do not happen in isolation, but some main sources or factors cause these accidents. These factors include human negligence, which results in unsafe behavior, and the leadership style. These factors will affect a worker's behavior, whether the worker is behaving safely or unsafely. Therefore, safety performance will be higher if the management is excellent and effective. In this context, companies must adopt a proactive approach to drive improvement in an increasingly complex and competitive environment. A leader can influence employees effectively, as employees actively interpret their leaders' behaviors, forming their own assessments of the leadership style in place [5]. Therefore, a positive leadership style can be a powerful approach to enhance employee engagement and performance.

Past studies have investigated how a leader's style affects safety performance, particularly in high-risk industries [5-21]. According to previous studies [18-20], transformational and transactional safety leadership styles will positively influence workers' safety behavior. Transformational leadership is when leaders leverage the organization's vision and objective to boost morale and motivation to work safely. Leaders' personalities might encourage their staff to collaborate safely in this situation. This leadership can inspire employees to change expectations, perceptions, and motivation to achieve common goals. Conchie et al. [7] examined the influence of supervisory behavior on workers. The research was conducted through focus group discussions with 69 supervisors, divided into four supervisory groups. The purpose of the study was to determine how context positively affects leadership behavior.

Meanwhile, according to previous studies [22-28], safety leadership will impact various aspects of safety performance, quantifiable using organizational measures, such as the cases of workplace accidents, injuries, deaths, and unsafe actions and conditions. The safety performance model, which includes safety performance, knowledge, and motivation, was developed by Griffin and Neal [29]. Safety compliance and involvement are among the factors used to assess safety performance. Safety compliance refers to following procedures and performing the job safely. Meanwhile, safety involvement or participation relates to employee behavior in creating an atmosphere that supports safety, such as helping colleagues and promoting safety programs at work, showing initiative, and improving safety at work [29]. Perceptions of safety knowledge and motivation differ from perceptions of the safety climate, which affect safety in the workplace [29]. Jiang and Probst [30] found that workers who are more knowledgeable about safety and are motivated by safety behaviors may increase their cognitive processes about behaviors that result in work safety participation. The impact of safety behavior in the oil and gas project has also been studied in the past [30], showing that increasing awareness and understanding of work safety reduces the risk of accidents.

Apart from the abovementioned factors, safety programs can also influence worker safety behaviors [31]. Safety programs are mandatory, and a company must be mandated and regulated in R.I. Law No. 1 of 1970, the Act of Occupational Safety. These programs can protect workers from work accidents, creating a safe, healthy workplace without environmental pollution. Some safety programs implemented in the oil and gas construction project include safety meetings, safety talks, and inspections. A safety program in a construction project will increase worker awareness and teach lessons from work accidents.

This study tests several hypotheses to examine the positive effects of transformational and transactional leadership styles and safety programs on safety behavior mediated by safety climate, knowledge, and motivation.

2. LITERATURE REVIEW AND HYPOTHESIS

2.1 Transformational and transactional leadership

Leadership that may transform people encompasses complex behaviors, such as acting as an ideal role model, inspiring and motivating others, encouraging intellectual growth, and offering individualized support [27]. Meanwhile, transactional leadership refers to transactions between leaders, subordinates, and colleagues. Transactional leaders recognize what actions subordinates must take to achieve results and clarify the requirements of these roles and tasks so that subordinates can exert the effort necessary to meet the leader's expectations [25, 26]. According to Clarke [18, 27], transformational and transactional leadership styles in the safety aspect can predict security problems. Jiang and Probst [30] and Shi and Zainal [25, 26] explained that leaders with this leadership style can describe good interactions between leaders and workers related to safety aspects and encourage motivational efforts in campaigning for safety programs. When a leader shows concern for the welfare of employees and develops high-quality relationships with these employees, positive perceptions of management can be created and improved, encouraging employees to carry out safety behavior in return [19-31]. Additional studies have demonstrated a positive link between transformational leadership in safety and both employee safety behaviors and the overall safety climate [32-35]. Therefore, the hypotheses proposed are as follows:

Hypothesis 1: Transformational leadership significantly enhances safety behavior.

Hypothesis 2: Transactional leadership significantly enhances safety behavior.

Hypothesis 3: Transformational leadership significantly enhances safety climate.

Hypothesis 4: Transactional leadership significantly enhances safety climate.

2.2 Safety program

Companies should implement safety programs to establish safe and comfortable working conditions, demonstrating the company’s commitment to preventing workplace accidents. These programs often include safety meetings, safety talks, equipment inspections, joint safety checks, and other related initiatives. Research indicates that safety programs positively influence worker satisfaction [31]. This study will examine the effects of safety programs on safety behavior and climate in construction projects. The offered hypotheses are:

Hypothesis 5: Safety programs significantly enhance safety behavior.

Hypothesis 6: Safety programs significantly enhance safety climate.

2.3 Safety climate

Safety climate represents workers' views of an organization's safety-related standards, protocols, and actions, helping them understand the importance of workplace safety within the industry [36-49]. Previous studies have extensively examined the development of a conceptual framework for the safety climate variable, particularly exploring its links with safety knowledge and motivation [30, 31, 49], as well as with safety behavior [30-32, 47-54]. Based on established links between safety climate and other variables, the following hypotheses are proposed:

Hypothesis 7: Safety climate significantly enhances safety knowledge.

Hypothesis 8: Safety climate significantly enhances safety motivation.

Hypothesis 9: Safety climate significantly enhances safety behavior.

Hypothesis 10a: Safety climate mediates the impact of safety transformational leadership on safety knowledge.

Hypothesis 10b: Safety climate mediates the impact of safety transactional leadership on safety knowledge.

Hypothesis 10c: Safety climate mediates the impact of safety programs on safety knowledge.

Hypothesis 11a: Safety climate mediates the impact of safety transformational leadership on safety motivation.

Hypothesis 11b: Safety climate mediates the impact of safety transactional leadership on safety motivation.

Hypothesis 11c: Safety climate mediates the impact of safety programs on safety motivation.

Hypothesis 12a: Safety climate mediates the impact of safety transformational leadership on safety behavior.

Hypothesis 12b: Safety climate mediates the impact of safety transactional leadership on safety behavior.

Hypothesis 12c: Safety climate mediates the impact of safety programs on safety behavior.

2.4 Safety knowledge

Safety behavior and safety knowledge are interconnected [55-57]. Safety knowledge helps more experienced workers behave safely [56, 57]. The level of safety awareness in the project area indicates how well-versed construction workers are in safety protocols and practices within construction companies [56, 57]. Thus, the following hypotheses are put forth:

Hypothesis 13: Safety knowledge enhances safety behavior.

Hypothesis 14: Safety knowledge mediates the impact of safety climate on safety behavior.

2.5 Safety motivation

Safety motivation is workers' willingness to act and behave safely where they work. It differs from safety knowledge, climate, and behavior, each of which influences workplace safety in distinct ways [57, 58]. Construction workers' safety motivation represents their tendency to complete jobs or activities safely [58]. In this case, safety motivation as a mediating variable is expected to prove the following hypotheses:

Hypothesis 15: Safety motivation enhances safety behavior.

Hypothesis 16: Safety motivation mediates the impact of safety climate on safety behavior.

Figure 3 shows the conceptual model constructed from the hypotheses, consisting of exogenous, endogenous, and mediating variables.

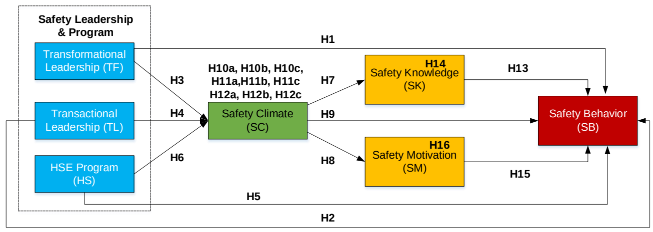

Figure 3. Conceptual model of this work

3. MATERIALS AND METHOD

This study is quantitative in nature, with questionnaires and surveys as data collection methods. Descriptive statistical analysis was carried out utilizing structural equation modelling (SEM). The variables consist of a) dependent variable/endogenous, i.e., safety behavior; b) mediation variables, i.e., safety climate, knowledge, motivation, and c) independent/exogenous variables, i.e., transformational leadership, transactional leadership, and safety programs. For detailed questionnaires of the seven variables in this study, please refer to Appendix A.

This study targets workers at both supervisory levels (including superintendents, supervisors, foremen, and group leaders) and operational levels, such as civil, mechanical, and electrical workers. The sample size for SEM analysis varies across different perspectives. The sample size in this study was calculated using Slovin's formula [59], as outlined below:

$$n = \frac{N}{1+N\,e^2} \tag{1}$$

where, N = the total population of project workers; n = number of samples; e = fault tolerance limit (*error tolerance*).

The Slovin formula can be used to determine how many samples are required for this investigation:

$$n = \frac{14{,}778}{1+(14{,}778)\,(3.75\%)^2} = \frac{14{,}778}{21.782} = 678.46$$

Thus, the research sample must be rounded up to 675 workers with various types of work, positions, ages, and occupations.

This research utilized two data collection techniques: first, questionnaires administered to respondents, and second, surveys conducted with respondents both in the field and at the office, which served as the primary research sites. This study employs data analysis techniques utilizing the 20.0 version of AMOS software and version 15.0 of SPSS, which runs on an AMD A9 Notebook processor with 4GB RAM. AMOS software is one of the software used to analyze with the variant-based SEM method, which may test the structural and measurement models at the same time. The measurement model assesses validity and reliability, while the structural model examines causality through hypothesis testing and predictive analysis.

4. RESULTS AND ANALYSIS

4.1 Respondent's demographics

This study was designed to target 675 workers from diverse roles within the oil and gas construction project. Table 1 shows the demographics of the participants in the study. The results showed that male respondents were dominant, namely 649 workers (96.15%), and there were only 26 female workers (3.85%). Respondents aged 20-30, 31-41, and 41-50 years ranked first, second, and third, respectively, with 301, 205, and 119 respondents. Regarding educational background, most respondents held a Bachelor's degree (S1), with 386 individuals (57.19%). This was followed by those with a high school or vocational school education, totaling 152 individuals (22.52%), and those with a postgraduate degree, totaling 61 individuals (9.04%). Most respondents belonged to the Construction function, with 323 individuals (47.85%). This was followed by the HSSE division, comprising 165 individuals (24.44%), and the Procurement and GS division, with 56 individuals (8.30%). In terms of employment level, the respondents who filled out the questionnaire mainly were workers or staff positions, namely 474 people (70.22%), supervisory level or supervisors, as many as 145 people (21.48%), and group leaders or supervisors, as many as 56 people (8.30%). Most respondents had less than five years of work experience, totaling 498 individuals (73.8%). Those with 5–10 years of experience comprised 78 individuals (11.56%), while 55 individuals (8.15%) had 11–15 years of experience.

Table 1. Respondent demographics

Characteristics of Respondents	Classification	Amount	Percentage (%)
Gender	Men	649	96.15
	Women	26	3.85
	Total	**675**	**100**
Age (years)	< 20	17	2.52
	20 – 30	301	44.59
	31 – 40	205	30.37
	41 – 50	119	17.63
	> 50	33	4.89
	Total	**675**	**100**
Last education	< High School	28	4.15
	High School	152	22.52
	Diploma	48	7.11
	Bachelor (S1)	386	57.19
	Postgraduate	61	9.04
	Total	**675**	**100**
Function	Construction	323	47.85
	CSU	30	4.44
	HSSE	165	24.44
	Engineering	37	5.48
	QA/QC	38	5.63
	Project Control	20	2.96
	Procurement & GS	56	8.30
	Interface	6	0.89
	Total	**675**	**100**
Position Level	Supervisor	145	21.48
	Group Leader	56	8.30
	Staff worker	474	70.22
	Total	**675**	**100**
Length of work	< 5 years	498	73.78
	5 – 10 years	78	11.56
	11 – 15 years	55	8.15
	16 – 20 years	26	3.85
	> 20 years	18	2.67
	Total	**675**	**100**

4.2 Validity and reliability test

This study tested the validity of the seven variables, i.e., transformational leadership, transactional leadership, safety program, climate, motivation, knowledge, and behavior. The transformational leadership variable in this study comprises eight indicators: encouragement to prioritize safety (TF1), confidence-building for safe work practices (TF2), modeling safe behavior (TF3), assurance of recognition for achievements (TF4), promoting open communication on safety (TF5), commitment to safe work practices (TF6), dedicating time to demonstrate the safest work methods (TF7), and listening to concerns regarding work safety (TF8). In transactional leadership, six indicators are identified: taking action in response to problems or incidents (TL1), issuing warnings (TL2), conducting overall supervision (TL3), providing guidelines for safe work practices (TL4), taking corrective actions for mistakes (TL5), and monitoring work errors (TL6). In the safety program, there are four indicators, namely demonstrating OSH commitment in the workplace (HS1), OSH documents/procedures for working safely (HS2), knowing all OSH programs (HS3), and implementation of an OSH program in the project. The safety climate variable consists of five indicators: quickly learning and adhering to OSH practices and standards (SC1), collectively ensuring the safest working conditions (SC2), maintaining zero tolerance for safety violations (SC3), prioritizing worker safety (SC4), and allowing freedom to report safety concerns (SC5).

Safety knowledge consists of five indicators, namely the application of OSH management, posters, and OSH signs in the project area (SK1), the use of equipment must comply with applicable procedures (SK2), knowledge of material safety data sheet (MSDS) (SK3), knowledge of the permit to work (PTW) (SK4), and knowledge of first aid room facilities (SK5). In the safety motivation variable, there are five indicators, namely sufficient salary to meet daily needs (SM1), facilities and infrastructure to support work activities (SM2), guaranteeing the health of workers through the social and health program (SM3), giving appreciation or praise for work results (SM4), and a safe and comfortable work environment (SM5). Lastly, the safety behavior variable consists of six indicators: using all Personal Protective Equipment (PPE) according to standards (SB1), working according to applicable procedures and standards (SB2), undergoing daily health check-ups (SB3), participating in safety campaigns (SB4), avoiding joking with co-workers and engaging in dangerous activities (SB5), and reprimanding colleagues, supervisors, and management if work is not safe (SB6).

The validity test results show that the R-count and R-table for each statement item from these variables are declared valid. This can be evaluated on the R-table for 675 respondents with α 0.05 = 0.071. The R-count that is bigger than the R-table confirms the validity of all statement items, so all indicators from these variables can be further analyzed.

Furthermore, reliability testing was carried out on the seven variables. This test aims to see whether each variable is reliable or consistent with the proposed questionnaire. Cronbach's alpha approach is used in reliability testing. This method measures the lower limit of a variable's reliability value. Table 2 displays Cronbach's alpha findings, with a critical value of α = 0.05 for each variable, which is reasonably reliable. With this research instrument, further analysis can be carried out.

Table 2. Research instrument reliability test results

No.	Variable	Number of Instruments	*Alpha Cronbach*	Remark
1	Transformational Leadership	8	0.769	Reliable
2	Transactional Leadership	6	0.787	Reliable
3	Safety Program	4	0.715	Reliable
4	Safety Climate	5	0.701	Reliable
5	Safety Motivation	5	0.719	Reliable
6	Safety Knowledge	5	0.753	Reliable
7	Safety Behaviour	6	0.713	Reliable

4.3 Confirmatory analysis test

Next, we determined whether each indicator was significant to measure the latent variable construct using confirmatory analysis factors. Confirmatory analysis was carried out on exogenous variables: transformational leadership, transactional leadership, and safety program variables. The confirmatory factor analysis for the exogenous variables, evaluated based on the regression weight significance and loading factors, yielded a Chi-Square value of 2,690.788, with *p-value* = 0.000; GFI of 0.737; The AGFI was 0.653, and the RMSEA was 0.181 which indicated that the exogenous variable model was still not fit and would be used to develop an overall model. The confirmatory test was carried out on endogenous variables, namely on the variables of safety climate, motivation, knowledge, and behavior. The results of the endogenous variable confirmatory test were the Chi-Square value of 2,786.890, with a *p-value* = 0.000, GFI of 0.737 (less than 0.9), AGFI of 0.658 (less than 0.9) and RMSEA of 0.164 (more than 0.08), TLI of 0.503 (less than 0.9), and CFI of 0.575 (less than 0.9), which indicates the endogenous variable model was still not fit and would be used to develop an overall model.

Table 3. Results of the Goodness of Fit criteria in the initial overall model

Goodness of the Fit Index	Criteria	Cut of Value	Remarks
Chi-Square	Must be Small	10,943.24	Not Fit
Sig. Probability	≥ 0.05	0.000	Not Fit
RMSEA	≤ 0.08	0.163	Not Fit
GFI	≥ 0.90	0.575	Not Fit
AGFI	≥ 0.90	0.513	Not Fit
TLI	≥ 0.90	0.381	Not Fit
CFI	≥ 0.90	0.430	Not Fit

After conducting confirmatory tests on exogenous and endogenous variables, an initial overall model was compiled by correlating all variables based on the theoretical framework and hypotheses to obtain the results in Table 3. According to the table, the overall model's results prior to improvement were not fit, with a p-value of 0.000 and a Chi-Square value of 10,943.241. Also, the GFI was 0.575 (less than 0.9), AGFI was 0.513 (less than 0.9), and RMSEA was 0.163 (more than 0.08), TLI was 0.381 (less than 0.9), and CFI was 0.430 (less than 0.9). Therefore, improvements were made by linking and removing each indicator according to the directions given by the modification indices. So that the results of the final overall model would be obtained with modification indices, repairing the model with modification indices would produce an optimal final overall model goodness of fit value.

Table 4. Results of the Goodness of Fit criteria in the final overall model

Goodness of the Fit Index	Criteria	Cut of Value	Remarks
Chi-Square	Must be Small	97.132	Good Fit
Sig. Probability	≥ 0.05	0.107	Good Fit
RMSEA	≤ 0.08	0.017	Good Fit
GFI	≥ 0.90	0.985	Good Fit
AGFI	≥ 0.90	0.964	Good Fit
TLI	≥ 0.90	0.993	Good Fit
CFI	≥ 0.90	0.997	Good Fit

Then, in the final overall model, improvements are made by correlating between indicators and eliminating several indicators based on modification indices directives. The number of indicators omitted is 19: TF3, TF4, TF6, TF7, TL1, TL3, TL4, TL6, HS2, SC2, SC3, SC4, SC5, SM2, SM3, SK3, SB1, SB5, SB6. Table 4 displays the findings of the goodness of fit criterion for the final model following model repair using modification indices on the final overall model diagram. Table 4 and Figure 4 show the Goodness of Fit criteria, with the chi-square value decreasing from 10,964.474 to 97.132, with a probability *p-value* = 0.107 (with conditions ≥ 0.05), GFI of 0.985 (more than 0.9), AGFI of 0.964 (more than 0.9), and RMSEA of 0.017 (less than 0.08), TLI of 0.993 (more than 0.9), and CFI of 0.997 (more than 0.9). Therefore, the final overall model with modification indices was a good fit.

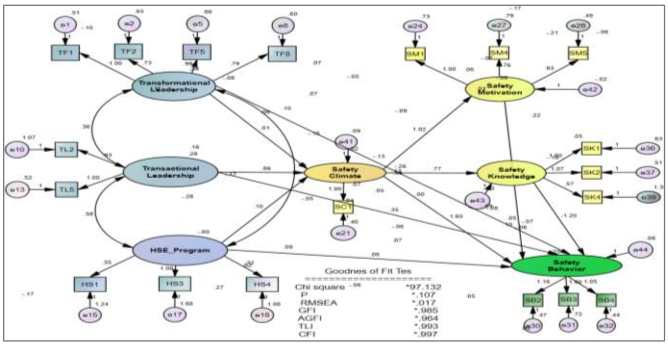

Figure 4. Final overall model

4.4 Model evaluation

This subsection presents the test for each indicator by measuring the significance of the latent variable using confirmatory factor analysis. The analysis is based on exogenous and endogenous variables: transformational leadership, transactional leadership, safety program, climate, motivation, knowledge, and behavior. Then, these variables are covariant with the results of the diagram's output, and the loading factor from the confirmatory analysis is shown in Table 5.

Table 5. Loading factor value

Variable	Indicator	Loading Factor	
		Initial	Final
Transformational Leadership	TF1	0.599	0.655
	TF2	0.437	0.424
	TF3	0.641	-
	TF4	0.370	-
	TF5	0.624	0.589
	TF6	0.358	-
	TF7	0.657	-
	TF8	0.535	0.532
Transactional Leadership	TL1	0.597	-
	TL2	0.365	0.436
	TL3	0.805	-
	TL4	0.630	-
	TL5	0.640	0.598
	TL6	0.622	-
Safety Program	HS1	0.176	-
	HS2	0.002	-
	HS3	0.594	-
	HS4	0.185	-
Safety Climate	SC1	0.677	0.705
	SC2	0.376	-
	SC3	0.658	-
	SC4	0.704	-
	SC5	0.376	-
Safety Motivation	SM1	0.549	0.589
	SM2	0.567	-
	SM3	0.090	-
	SM4	0.510	0.468
	SM5	0.685	0.639
Safety Knowledge	SK1	0.578	0.498
	SK2	0.707	0.505
	SK3	0.101	-
	SK4	0.191	-
	SK5	0.203	-
Safety Behavior	SB1	0.739	-
	SB2	0.659	0.718
	SB3	0.504	0.608
	SB4	0.674	0.747
	SB5	0.211	-
	SB6	0.510	-.

Table 5 shows the initial and final loading factors for all indicators. Three indicators show insignificant and invalid values in the initial loading factor, namely the HS2, SM3, and SK3 indicators, with loading factor < 0.5 and p-value ≥ 0.001. Thus, the total indicators tested and the rest (36 indicators) could be declared valid. Three insignificant and invalid variables could be removed from the initial model. The table also shows 11 significant and valid loading factor final indicators with a final loading factor value of ≥ 0.5. However, several factors, such as TF2, TL2, SK1, and SM4, could be declared valid because their values were close to 0.5. The significant p-value for the final model also supports this, with p = 0.107 (*p-value* $\geq$ 0.05).

4.5 Hypothesis test

The next analysis to be carried out is an analysis of hypothesis testing. This analysis was conducted to test whether the hypothesis proposed in the research statement has been proven significantly or vice versa. Hypothesis testing analysis was carried out on twenty-two (22) hypotheses that had been proposed in the study, where this test was carried out by analyzing the critical ratio (C.R.) and Sobel Test values and the probability of a causal relationship between variables (p-value). An example of calculating the Sobel test on H10a is as follows:

$$Z_{count} = \frac{ab}{SE_{ab}} = \frac{ab}{\sqrt{b^2 SE_a^2 + a^2 SE_b^2}}$$

$$Z_{count} = \frac{(0.009) \times (0.766)}{\sqrt{(0.766)^2 \times (0.521)^2 + (0.009)^2 \times (0.059)^2}}$$

$$Z_{count} = \frac{(0.009) \times (0.766)}{\sqrt{1.16021}} = 0.0172$$

According to the results of the computation of the Sobel value, the Z-count value is 0.0172. The value of Z-count < Z-table (0.0172 < 1.96) indicates that safety climate does not mediate the impact of safety transformational leadership on safety knowledge. These findings imply that hypothesis 10a (H10a) was rejected. Table 6 shows the results of testing the proposed hypothesis; five hypotheses received a significant positive effect, namely H7, H8, H9, H13, and H14. The remaining 17 tested hypotheses were all rejected, meaning they did not have a significant positive effect on the statistical test results. The conceptual model illustrates the influence of safety leadership & program on safety behavior, mediated by safety climate, safety knowledge, and safety motivation is shown in Figure 5.

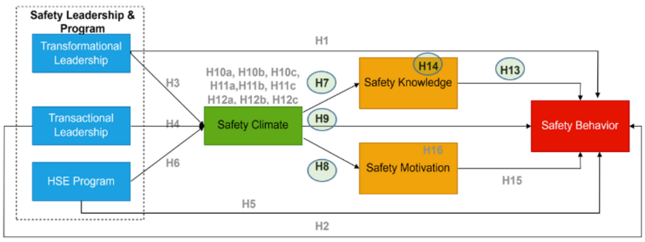

Figure 5. Results of relationships between safety leadership, climate, and behavior in the oil and gas construction project

Table 6. Results of hypothesis

Hypothesis	Variable Relations a)	C.R. or the Sobel Test	p-Value	Conclusion
H1	TF --> SB	-0.627	0.530	Not Significant
H2	TL --> SB	0.991	0.322	Not Significant
H3	TF --> SC	0.017	0.986	Not Significant
H4	TL --> SC	1.753	0.080	Not Significant
H5	HS --> SB	0.933	0.351	Not Significant
H6	HS --> SC	1.275	0.202	Not Significant
H7	SC --> SK	13.007	***	Significant
H8	SC --> SM	15.304	***	Significant
H9	SC --> SB	4.420	***	Significant
H10a	TF --> SC --> SK	0.017	0.980	Not Significant
H10b	TL --> SC --> SK	1.730	0.080	Not Significant

Hypothesis	Variable Relations a)	C.R. or the Sobel Test	p-Value	Conclusion
H10c	HS --> SC --> SK	1.270	0.200	Not Significant
H11a	TF --> SC --> SM	0.017	0.980	Not Significant
H11b	TL --> SC --> SM	1.736	0.080	Not Significant
H11c	HS --> SC --> SM	1.273	0.200	Not Significant
H12a	TF --> SC --> SB	0.017	0.980	Not Significant
H12b	TL --> SC --> SB	1.593	0.103	Not Significant
H12c	HS --> SC – SB	1.202	0.210	Not Significant
H13	SK --> SB	-2.980	0.003	Significant
H14	SC --> SK --> SB	-2.896	0.003	Significant
H15	SM --> SB	-0.781	0.435	Not Significant
H16	SC --> SM --> SB	-0.780	0.430	Not Significant

a) TF = transformational leadership, TL = transactional leadership, HS = safety program, SB = safety behaviour, SC = safety climate, SM = safety motivation, and SK = safety knowledge.
***) indicate that the hypotheses are significant.

5. DISCUSSION

5.1 The influence of transformational and transactional leadership on safety behavior and climate

The project's research findings revealed that the results of hypotheses H1, H2, H3, and H4 were statistically rejected. These results indicate that transformational leadership does not enhance safety behavior (H1 was rejected); transactional leadership does not enhance safety behavior (H2 was rejected); transformational leadership does not enhance safety climate (H3 was rejected); transactional leadership does not enhance the safety climate (H4 was rejected). This study's findings contradict those of numerous earlier investigations, such as those conducted by previous studies [26-28, 31, 35, 40, 47-49]. Previous studies have stated that safety leadership can motivate or inspire and lead to transactional processes between leaders, subordinates, and co-workers. This study indicates that if management seeks to improve safety climate and behavior, company leaders must increase safety leadership (transformational and transactional leadership styles). In addition, this research also shows the need for workers' perceptions of safety concerns, which is an indicator of safety leadership.

5.2 The influence of safety programs on safety behavior and climate

Furthermore, the statistical test results found that hypotheses H5 and H6 were statistically rejected. These results show that safety programs do not enhance safety behavior (H5 was rejected) or safety climate (H6 was rejected). The results of this study contradict previous studies [26, 27, 32], stating that safety programs enhance safety behavior. Safety programs aim to create a safe and healthy workplace to protect workers from accidents, provided that the occupational safety and health program has been implemented optimally. The programs can produce good safety behavior and climate to improve company safety performance.

5.3 The influence and mediation of safety climate on safety knowledge, motivation, and behavior

This section analyzes two test results: direct and indirect testing (mediation). In direct hypothesis testing, three hypotheses are tested: H7, H8, and H9. Three hypotheses were accepted statistically, which meant that safety climate enhances safety knowledge (H7 was accepted), motivation (H8 was accepted), and behavior (H9 was accepted). The findings of this study align with past research, where safety climate positively impacted safety knowledge and motivation [26, 27, 50], and safety climate enhanced safety behavior [26-28, 49, 54]. The study's findings suggest that safety knowledge, motivation, and behavior increase with a more robust safety climate. The findings underscore the critical role of a strong safety climate in enhancing safety knowledge, motivation, and behavior among workers, encouraging adherence to safety protocols in line with the company's standard operating procedures. Both theoretical insights and empirical data suggest improving workers' safety knowledge, motivation, and behaviors. This requires embedding core values and beliefs that align with knowledge, skills, abilities, motivation, and personality—factors essential for fostering a safety-oriented culture and supporting compliance with safety behaviors.

In the indirect hypothesis testing, nine hypotheses (from H10a to H12c) were tested for the mediation roles. Based on the SEM results, it was found that the results of the nine hypotheses were rejected statistically. The nine hypotheses showed that transformational leadership, transactional leadership, and safety programs do not impact safety knowledge, motivation, and behavior through safety climate. The findings of this study differ from those studies [28, 49, 53, 54], which state that safety climate positively mediates these variables. The empirical data showed that increasing safety leadership and programs to promote a safety climate is necessary to increase safety knowledge, motivation, and behavior. In other words, workers' perceptions of safety motivation, policies, and safety concerns—indicators of a safe climate—are crucial.

5.4 The effect of safety knowledge on safety behavior and safety knowledge as a mediation

In this test, there is one direct hypothesis for safety knowledge's impact on safety behavior, namely H13, and one indirect hypothesis, where safety knowledge is the mediating variable, namely H14. Based on the SEM results, the two hypotheses were statistically accepted. The results indicate a significant positive impact of safety knowledge on safety behavior (supporting H13) and a similarly positive influence of safety climate on safety behavior mediated by safety knowledge (supporting H14). These findings align with previous research, affirming that increased safety knowledge enhances safety behavior [31]. The data reveal that as safety knowledge rises, so does safety behavior; similarly, a higher safety climate, coupled with higher safety knowledge, strengthens safety behavior. These findings underscore the critical role of safety knowledge in promoting safe work practices, as it equips workers with an essential understanding of safety procedures, standards, and policies, thereby fostering a culture of safe behavior in the workplace.

5.5 The effect of safety motivation on safety behavior and safety motivation as a mediation

In this last section, there is one direct hypothesis for safety motivation on safety behavior, namely H15, and one indirect hypothesis, where safety motivation is a mediating variable, namely H16. The SEM analysis results led to the statistical rejection of two hypotheses. Specifically, safety motivation does not enhance safety behavior (rejecting H15), and safety climate does not enhance safety behavior through safety motivation (rejecting H16). These findings contradict prior researches [26, 27, 31], which posits a positive relationship between safety motivation and safety behavior. To increase the safety motivation of workers, management needs to implement several programs, such as increasing salaries, providing facilities and infrastructure that support work, providing health and safety insurance, giving appreciation, and others. With these programs, company management can improve safety behavior and climate in the work environment to reduce the number of incidents and improve safety performance. The results demonstrate that worker safety motivation is just as significant as safety knowledge regarding safety behaviour. Together, raising employee safety motivation and safety awareness can promote worker safety behaviour.

6. PRACTICAL IMPLICATIONS

The findings of this study carry several practical implications for enhancing safety performance in the oil and gas construction sector in Indonesia. First, the lack of significant effects from both transformational and transactional leadership on safety behavior and climate suggests that leadership styles alone may not be enough to drive the desired safety outcomes. This underscores the importance of leaders taking a more comprehensive approach to safety management, integrating clear communication, effective safety training, and continuous monitoring. Furthermore, this research highlights the need for workers' perceptions of safety concerns and leadership styles, suggesting that a more collaborative and proactive leadership approach could strengthen the safety culture in these high-risk environments. In addition, the high turnover rate in the construction sector adds another layer of complexity to safety management. New workers, often lacking sufficient exposure to safety practices, may not be adequately prepared to follow safety protocols, increasing the risk of accidents. Therefore, leaders must implement strategies that not only focus on leadership styles but also address the transient nature of the workforce.

According to previous study [60], wrong decisions made by top management can directly influence supervisory practices, as well as affect worker conditions and actions. In practice, these organizational errors are often overlooked by safety professionals, primarily due to the lack of a clear framework for investigating them. Latent failures, which are the most difficult to understand, generally revolve around issues related to resource management, organizational climate, and organizational processes as shown in Figure 6. This categorization is highly relevant to organizations, as several factors within these areas received significant attention. For instance, in terms of resource management, issues such as a lack of available manpower for leadership and supervision, insufficient training (which is often treated as a mandatory requirement without ongoing refreshers for civil workers), and financial difficulties hindering the improvement of organizational culture and performance are critical. Moreover, safety communication, an element of organizational climate, also plays a role in the safety culture. Therefore, improvements in safety communication and resource support can foster safety leadership, leading to better safety behavior.

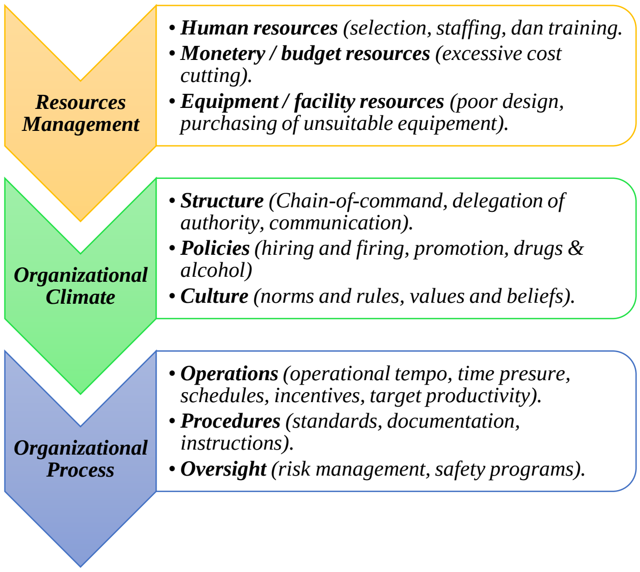

Figure 6. Distribution of organizational influence on workplace accidents [60]

Additionally, the study's findings regarding safety programs indicate that merely implementing safety initiatives is insufficient if these programs are not optimized or well-received by workers. The rejection of safety programs' impact on safety behavior and climate signals a gap between policy and practice. For safety programs to be effective, they must be tailored to meet the specific needs of the workforce, with ongoing engagement and feedback mechanisms to ensure workers perceive the programs as valuable. With the high turnover in construction, it becomes even more critical to create programs that are flexible and adaptable to the diverse needs of both new and experienced workers. These programs should include comprehensive training, clear communication of safety expectations, and continuous evaluation to align with workers' evolving needs.

Organizations must integrate safety leadership with robust, worker-centered safety programs and focus on fostering a strong safety climate to enhance safety knowledge, motivation, and behavior. A strong safety climate is crucial for encouraging adherence to safety practices and ensuring that all workers, regardless of their tenure or experience, understand and follow safety protocols. By continuously improving and adapting safety programs to address the unique challenges of a high-turnover workforce, companies can ensure that safety is consistently prioritized. Finally, combining strong leadership with effective, worker-oriented safety programs will reduce workplace accidents and foster a culture of safety, contributing to improved safety outcomes in the construction oil and gas sector.

7. CONCLUSION AND RECOMMENDATION

7.1 Conclusion

From studies conducted on the oil and gas construction project, several conclusions were obtained from testing twenty-two hypotheses through SEM analysis. The SEM assumption test, instrument validity, reliability tests, and model-fit evaluation confirm that the overall model developed is well-suited, indicating alignment between theoretical expectations and empirical findings. Key conclusions include a positive and significant relationship between safety climate and safety knowledge, suggesting that improvements in the safety climate led to corresponding increases in safety knowledge. These findings provide insight to company managers to provide an exemplary safety climate in the work area to encourage workers to take part in worker-related training to increase knowledge about work safety.

Additionally, the study found a positive and significant relationship between safety climate and safety motivation, indicating that an enhanced safety climate leads to increased safety motivation among workers. This insight is valuable for safety managers aiming to foster a proactive safety climate that encourages worker engagement with safety practices. The analysis also confirms a positive and significant influence of safety climate on safety behavior, suggesting that as the safety climate improves, so does the frequency of safe practices among workers. This connection underscores the value of continuously refining the safety climate to enhance employees' knowledge, skills, motivation, and safety behavior. Furthermore, a significant positive effect was observed between safety knowledge and safety behavior, indicating that increases in safety knowledge directly correlate with more consistent safety behavior on the job. If workers' behavior needs to be improved, then workers' safety knowledge needs to be improved first. Mediated by safety knowledge, the safety climate positively and significantly impacts safety behavior.

The research findings reveal that the data from the project did not support some hypothesized relationships. Specifically, transformational leadership, transactional leadership, and safety programs did not show an impact on either safety climate or safety behavior. Additionally, safety leadership and safety programs did not influence safety knowledge, motivation, or behavior when mediated by safety climate. Similarly, no connection was observed between safety motivation and safety behavior, nor between safety climate and safety behavior when mediated by safety motivation.

7.2 Recommendations

Several steps can be taken to draw managerial implications from the research findings. Safety climate directly influences safety knowledge, motivation, and behavior. Improving the safety climate within the project requires enhancing worker safety knowledge. This can be achieved by leveraging management to establish a system that promotes continuous education and training on safety procedures, especially in high-risk jobs, such as welding, lifting operations, working at height, and working in confined spaces. Training will increase workers' knowledge and improve the project's working climate. In addition, workers need to be evaluated during training so that the training implementation can be proven effective. In providing this training, management must create innovative and continuous programs and encourage workers to increase their knowledge, skills, abilities, intelligence, motivation, and personality, which is done voluntarily and not forced so that indicators in particular safety behavior can be achieved. Additionally, safety knowledge has a direct impact on safety behavior, while safety climate influences safety behavior indirectly through safety knowledge. Therefore, to enhance safety behavior in the oil and gas project, it is essential to focus on increasing safety knowledge among workers and cultivating a positive safety climate.

REFERENCES

[1] International Organization Labour (2018). Improving young workers' safety and health. Jakarta: ILO. Retrieved from: http://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/---ilo-jakarta/documents/presentation/wcms_627851.pdf.

[2] Arifuddin, R., Latief, R.U., Suraji, A. (2020). An investigation of fall accident in a high-rise building project. IOP Conference Series: Earth and Environmental Science, 419(1): 012144. https://doi.org/10.1088/1755-1315/419/1/012144

[3] Sudiarno, A., Amanullah, D.A., Akbar, R.A. (2022). The measurement of evacuation effectiveness regarding dynamic evacuation routing system (DERS) in high-rise building using virtual reality simulation. International Journal of Safety & Security Engineering, 12(1): 115-122. https://doi.org/10.18280/ijsse.120114

[4] Kavianian, H.R., Wentz, C.A. (1990). Occupational and environmental safety engineering and management. Van Nostrand Reinhold Company.

[5] Cheng, J.W., Chang, S.C., Kuo, J.H., Cheung, Y.H. (2014). Ethical leadership, work engagement, and voice behaviour. Industrial Management & Data Systems, 114(5): 817-831. https://doi.org/10.1108/IMDS-10-2013-0429

[6] Clarke, S., Ward, K. (2006). The role of the leader influences tactics and safety climate in engaging employees' safety participation. Risk Analysis, 26(5): 1175-1185. https://doi.org/10.1111/j.1539-6924.2006.00824.x

[7] Conchie, S.M., Donald, I.J. (2009). The moderating role of safety-specific trust on the relation between safety-specific leadership and safety citizenship behaviors. Journal of Occupational Health Psychology, 14(2): 137. https://doi.org/10.1037/a0014247

[8] Conchie, S.M., Taylor, P.J., Donald, I.J. (2012). Promoting safety voice with safety-specific transformational leadership: The mediating role of two dimensions of trust. Journal of Occupational Health Psychology, 17(1): 105. https://doi.org/10.1037/a0025101

[9] Conchie, S.M. (2013). Transformational leadership, intrinsic motivation, and trust: A moderated-mediated model of workplace safety. Journal of Occupational Health Psychology, 18(2): 198. https://doi.org/10.1037/a0031805

[10] Conchie, S.M., Moon, S., Duncan, M. (2013). Supervisors' engagement in safety leadership: Factors that help and hinder. Safety Science, 51(1): 109-117. https://doi.org/10.1016/j.ssci.2012.05.020

[11] Dahl, Ø., Olsen, E. (2013). Safety compliance on offshore platforms: A multi-sample survey on the role of perceived leadership involvement and work climate. Safety Science, 54: 17-26. https://doi.org/10.1016/j.ssci.2012.11.003

[12] Hoffmeister, K., Gibbons, A.M., Johnson, S.K., Cigularov, K.P., Chen, P.Y., Rosecrance, J.C. (2014). The differential effects of transformational leadership facets on employee safety. Safety Science, 62: 68-78. https://doi.org/10.1016/j.ssci.2013.07.004

[13] Lu, C.S., Lin, C.C. (2014). The effects of perceived culture difference and transformational leadership on job performance in the container shipping industry. Journal of Marine Science and Technology, 22(4): 8. https://jmstt.ntou.edu.tw/journal/vol22/iss4/8.

[14] Skeepers, N.C., Mbohwa, C. (2015). A study on the leadership behaviour, safety leadership and safety performance in the construction industry in South Africa. Procedia Manufacturing, 4: 10-16. https://doi.org/10.1016/j.promfg.2015.11.008

[15] Toderi, S., Balducci, C., Gaggia, A. (2016). Safety-specific transformational and passive leadership styles: A contribution to their measurement. TPM: Testing, Psychometrics, Methodology in Applied Psychology, 23(2): 167-183. https://doi.org/10.4473/TPM23.2.3

[16] Adjekum, D.K. (2017). An evaluation of the relationships between collegiate aviation safety management system initiative, self-efficacy, transformational safety leadership and safety behaviour mediated by safety motivation. International Journal of Aviation, Aeronautics, and Aerospace, 4(2): 4. https://doi.org/10.15394/ijaa.2017.1169

[17] Vignoli, M., Mariani, M.G., Guglielmi, D., Violante, F.S. (2018). Leadership styles and self-efficacy in determining transfer intentions of safety training. Journal of Workplace Learning, 30(1): 65-76. https://doi.org/10.1108/JWL-01-2017-0001

[18] Clarke, S. (2000). Safety culture: Under-specified and overrated? International Journal of Management Reviews, 2(1): 65-90. https://doi.org/10.1111/1468-2370.00031

[19] Lu, C.S., Yang, C.S. (2010). Safety leadership and safety behavior in container terminal operations. Safety Science, 48(2): 123-134. https://doi.org/10.1016/j.ssci.2009.05.003

[20] Sankar, S.S., Anandh, K.S., Rajendran, S., Ibrahim, C.K.I.C., Szóstak, M. (2023). Examining the relative importance and association between safety leadership styles and factors affecting organizational safety climate. Buildings, 13(8): 2062. https://doi.org/10.3390/buildings13082062

[21] Sankar, S.S., Anandh, K.S., Prasanna, K. (2024). Safety leadership: A catalyst for positive safety climate on construction sites. Buildings, 14(6): 1806. https://doi.org/10.3390/buildings14061806

[22] Yeboah, M.A., Kalvei, M., Ansong, L.O., Ansong, A. (2024). Responsible leadership and workplace safety: Do safety culture and safety motivation matter? Asia-Pacific Journal of Business Administration. https://doi.org/10.1108/APJBA-05-2023-0207

[23] Bauzir, A.M., Agustina, T.S. (2024). Safety participation on industrial company: Emphasize safety leadership and safety climate with safety knowledge as mediation. Revista de Gestão Social e Ambiental, 18(3): e06785-e06785. https://doi.org/10.24857/rgsa.v18n3-143

[24] Omidi, L., Karimi, H., Pilbeam, C., Mousavi, S., Moradi, G. (2024). Safety leadership and safety citizenship behavior: The mediating roles of safety knowledge, safety motivation, and psychological contract of safety. Theoretical Issues in Ergonomics Science, 2024: 2364870. https://doi.org/10.1080/1463922X.2024.2364870

[25] Shi, H., Zainal, S.R.M. (2021). Facilitating mindful safety practices among first-line workers in the Chinese petroleum industry through safety management practices and safety motivation. International Journal of Occupational Safety and Ergonomics, 2021: 1902672. https://doi.org/10.1080/10803548.2021.1902672

[26] Shi, H., Zainal, S.R.M. (2021). The influence of safety-specific transformational leadership and safety management practices on mindful safety practices through safety motivation: A study in the Chinese petroleum industry. Journal of Applied Security Research, 2021: 1882284. https://doi.org/10.1080/19361610.2021.1882284

[27] Clarke, S. (2013). Safety leadership: A meta-analytic review of transformational and transactional leadership styles as antecedents of safety behaviours. Journal of Occupational and Organizational Psychology, 86(1): 22-49. https://doi.org/10.1111/j.2044-8325.2012.02064.x

[28] Burke, M.J., Sarpy, S.A., Tesluk, P.E., Smith-crowe, K.R.I.S.T.I.N. (2002). General safety performance: A test of a grounded theoretical model. Personnel Psychology, 55(2): 429-457. https://doi.org/10.1111/j.1744-6570.2002.tb00116.x

[29] Griffin, M.A., Neal, A. (2000). Perceptions of safety at work: A framework for linking safety climate to safety performance, knowledge, and motivation. Journal of Occupational Health Psychology, 5(3): 347. https://doi.org/10.1037/1076-8998.5.3.347

[30] Jiang, L., Probst, T.M. (2016). Transformational and passive leadership as cross-level moderators of the relationships between safety knowledge, safety motivation, and safety participation. Journal of Safety Research, 57: 27-32. https://doi.org/10.1016/j.jsr.2016.03.002

[31] Karmawan, I.K.A., Sudibya, I.G.A. (2020). Pengaruh kepemimpinan transformasional, budaya organisasi, program keselamatan dan kesehatan kerja terhadap kepuasan kerja karyawan. E-Jurnal Manajemen Universitas Udayana, 9(1): 19. https://doi.org/10.24843/EJMUNUD.2020.v09.i01.p19

[32] O'Dea, A., Flin, R. (2001). Site managers and safety leadership in the offshore oil and gas industry. Safety Science, 37(1): 39-57. https://doi.org/10.1016/S0925-7535(00)00049-7

[33] Zohar, D. (2002). The effects of leadership dimensions, safety climate, and assigned priorities on minor injuries in work groups. Journal of Organizational Behavior, 23(1): 75-92. https://doi.org/10.1002/job.130

[34] Barling, J., Loughlin, C., Kelloway, E.K. (2002). Development and test of a model linking safety-specific transformational leadership and occupational safety.

Journal of Applied Psychology, 87(3): 488. https://doi.org/10.1037/0021-9010.87.3.488
[35] Wu, T.C. (2008). Safety leadership in the teaching laboratories of electrical and electronic engineering departments at Taiwanese Universities. Journal of Safety Research, 39(6): 599-607. https://doi.org/10.1016/j.jsr.2008.10.003
[36] Mullen, J.E., Kelloway, E.K. (2009). Safety leadership: A longitudinal study of the effects of transformational leadership on safety outcomes. Journal of Occupational and Organizational Psychology, 82(2): 253-272. https://doi.org/10.1348/096317908X325313
[37] Mullen, J., Kelloway, E.K., Teed, M. (2017). Employer safety obligations, transformational leadership and their interactive effects on employee safety performance. Safety Science, 91: 405-412. https://doi.org/10.1016/j.ssci.2016.09.007
[38] Mirza, M.Z., Isha, A.S.N.B. (2017). An approach towards safety leadership framework in manufacturing sector of Malaysia. Global Business & Management Research, 9(1S): 613-621. http://www.gbmrjournal.com/vol9no1s.htm.
[39] Bass, B.M., Avolio, B.J., Jung, D.I., Berson, Y. (2003). Predicting unit performance by assessing transformational and transactional leadership. Journal of Applied Psychology, 88(2): 207. https://doi.org/10.1037/0021-9010.88.2.207
[40] Avolio, B.J., Walumbwa, F.O., Weber, T.J. (2009). Leadership: Current theories, research, and future directions. Annual Review of Psychology, 60(1): 421-449. https://doi.org/10.1146/annurev.psych.60.110707.163621
[41] Li, M., Zhai, H., Zhang, J., Meng, X. (2020). Research on the relationship between safety leadership, safety attitude and safety citizenship behavior of railway employees. International Journal of Environmental Research and Public Health, 17(6): 1864. https://doi.org/10.3390/ijerph17061864
[42] Hiep, H.Y., Hien, N.N. (2023). Safety leadership, COVID-19 risk perception, and safety behavior: The moderator role of work pressure. International Journal of Safety and Security Engineering, 13(2): 255-266. https://doi.org/10.18280/ijsse.130208
[43] Indrayana, D.V., Pribadi, K.S., Marzuki, P.F., Iridiastadi, H. (2023). Safety leadership and performance in Indonesia's construction sector: The role of project owners' marurity. International Journal of Safety and Security Engineering, 13(4): 635-646. https://doi.org/10.18280/ijsse.130405
[44] Hien, N.N., Kiet, N.T., Nguyen, A.T. (2024). The influence of safety culture on safety attitude, personnel error behavior, and safety citizenship behavior: Research in the Vietnam oil and gas industry. International Journal of Safety and Security Engineering, 14(2): 399-409. https://doi.org/10.18280/ijsse.140208
[45] Amirah, N.A., Him, N.F.N., Rashid, A., Rasheed, R., Zaliha, T.N., Afthanorhan, A. (2024). Fostering a safety culture in manufacturing through safety behavior: A structural equation modelling approach. Journal of Safety and Sustainability, 1(2): 108-116. https://doi.org/10.1016/j.jsasus.2024.03.001
[46] Hu, P., Tanchak, R., Wang, Q. (2024). Developing risk assessment framework for wildfire in the United States–A deep learning approach to safety and sustainability. Journal of Safety and Sustainability, 1(1): 26-41. https://doi.org/10.1016/j.jsasus.2023.09.002
[47] Zhao, L., Yang, D., Liu, S., Nkrumah, E.N.K. (2022). The effect of safety leadership on safety participation of employee: A meta-analysis. Frontiers in Psychology, 13: 827694. https://doi.org/10.3389/fpsyg.2022.827694
[48] Saedi, A.M., Majid, A.A., Isa, Z. (2020). Relationships between safety climate and safety participation in the petroleum industry: A structural equation modeling approach. Safety Science, 121: 240-248. https://doi.org/10.1016/j.ssci.2019.08.045
[49] Shen, Y., Ju, C., Koh, T.Y., Rowlinson, S., Bridge, A.J. (2017). The impact of transformational leadership on safety climate and individual safety behavior on construction sites. International Journal of Environmental Research and Public Health, 14(1): 45. https://doi.org/10.3390/ijerph14010045
[50] Borman, W.C., Motowidlo, S.J. (1997). Task performance and contextual performance: The meaning for personnel selection research. Human Performance, 10(2): 99-109. https://doi.org/10.1207/s15327043hup1002_3
[51] Wang, D., Wang, X., Xia, N. (2018). How safety-related stress affects workers' safety behavior: The moderating role of psychological capital. Safety Science, 103: 247-259. https://doi.org/10.1016/j.ssci.2017.11.020
[52] Lee, Y.H., Lu, T.E., Yang, C.C., Chang, G. (2019). A multilevel approach on empowering leadership and safety behavior in the medical industry: The mediating effects of knowledge sharing and safety climate. Safety Science, 117: 1-9. https://doi.org/10.1016/j.ssci.2020.11.011
[53] Arief, Z., Eliyana, A., Anggraini, R.D., Sari, P.A. (2020). The effect of safety-specific transformational leadership and safety-specific passive leadership on safety behaviors mediated by safety climate. Systematic Reviews in Pharmacy, 11(11): 1715-1726. https://doi.org/10.5530/srp.2020.11.241
[54] Christian, M.S., Bradley, J.C., Wallace, J.C., Burke, M.J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. Journal of Applied Psychology, 94(5): 1103. https://doi.org/10.1037/a0016172
[55] Beus, J.M., McCord, M.A., Zohar, D. (2016). Workplace safety: A review and research synthesis. Organizational Psychology Review, 6(4): 352-381. https://doi.org/10.1177/2041386615626243
[56] Hofmann, D.A., Jacobs, R., Landy, F. (1995). High reliability process industries: Individual, micro, and macro-organizational influences on safety performance. Journal of Safety Research, 26(3): 131-149. https://doi.org/10.1016/0022-4375(95)00011-E
[57] Kao, K.Y., Spitzmueller, C., Cigularov, K., Thomas, C.L. (2019). Linking safety knowledge to safety behaviours: A moderated mediation of supervisor and worker safety attitudes. European Journal of Work and Organizational Psychology, 28(2): 206-220. https://doi.org/10.1080/1359432X.2019.1567492
[58] Bang, H.K., Ellinger, A.E., Hadjimarcou, J., Traichal, P.A. (2000). Consumer concern, knowledge, belief, and attitude toward renewable energy: An application of the reasoned action theory. Psychology & Marketing, 17(6):

449-468. https://doi.org/10.1002/(SICI)1520-6793(200006)17:6<449::AID-MAR2>3.0.CO;2-8
[59] Sevilla, C.G. (1992). Research Methods. Rex Bookstore, Inc.
[60] Shappell, S.A., Wiegmann, D.A. (2000). The human factors analysis and classification system--HFACS. https://commons.erau.edu/publication/737/.

APPENDIX A

The questionnaire was originally developed in Bahasa and later translated into English for this paper. All items were assessed using a five-point Likert scale, with verbal anchors ranging from “strongly disagree” at 1 to “strongly agree” at 5. Table A1 provides an overview of the items for TF, TL, HS, SC, SM, SK, and SB.

Table A1. Contents of questionnaire

Variable	Items
Section 1: Transformational Leadership (TF)	1. My supervisor encourages me to act safely in the workplace. 2. My supervisor trusts me to work safely. 3. My supervisor serves as a role model for safe behavior at workplace. 4. My supervisor ensures that I receive recognition for achieving safety targets at workplace. 5. My supervisor encourages me to voice my opinions about safety at workplace. 6. My supervisor demonstrates safety commitment to workplace. 7. My supervisor takes the time to show me the safest way to perform tasks at workplace. 8. My supervisor listens to my concerns about safety at workplace.
Section 2: Transactional Leadership (TL)	1. My supervisor reacts when problems or incidents occur in the workplace. 2. My supervisor provides warnings when rules are violated. 3. My supervisor thoroughly supervises my work. 4. My supervisor provides guidelines for working safely. 5. My supervisor takes corrective actions for my mistakes. 6. My supervisor consistently monitors my works at workplace.
Section 3: HSE Program (HS)	1. There is a commitment to HSE and management involvement in the workplace. 2. The company has HSE documents and procedures for working safely. 3. There are programs for hazard identification and risk assessment communication to workers in project areas (e.g., TBM, safety talks, safety meetings, etc.) 4. The current HSE training programs in the project are not running effectively.
Section 4: Safety Climate (SC)	1. The company or supervisor expects me to quickly learn and adhere to good or standard HSE practices. 2. All employees and management work together to ensure the safest conditions. 3. There is zero tolerance when worker safety is at risk. 4. Worker safety is the top priority over other aspects. 5. All employees feel free to report safety-related findings.
Section 5: Safety Motivation (SM)	1. My salary from the company is sufficient for my daily needs. 2. The company provides facilities and infrastructure to support work activities. 3. The company ensures workers' health through government social security programs. 4. My supervisor appreciates or praises me for my work achievements. 5. The workplace environment in the company and project area is safe and comfortable for work.
Section 6: Safety Knowledge (SK)	1. The implementation of HSE management, posters, and signage in project areas can prevent and reduce work accidents. 2. Using tools such as hand tools and heavy equipment must comply with applicable procedures. 3. Understanding the Material Safety Data Sheet (MSDS) for chemicals in project areas is important. 4. Working in project areas always require a Permit to Work (PTW). 5. First Aid facilities are essential in project areas.
Section 7: Safety Behaviour (SB)	1. I use all PPE according to standards when performing my job. 2. I work according to procedures and standards applicable in the project area where I work. 3. I usually perform daily health checks before entering the project area. 4. I participate in safety campaigns in project areas. 5. I sometimes joke with colleagues and engage in unsafe activities, such as rushing, being careless, or running. 6. I am willing to correct colleagues, supervisors, and management if they work unsafely, and I am also willing to be corrected if I work unsafely.