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Influence of Safety Climate on Safety Performance in Gas Stations in Indonesia

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Abstract: Accidents in gas stations may cause injury or even death to people. Moreover, an accident in a gas station might halt its operation for some time. When an accident takes place in a region with scant amount of gas stations, it may lead to fuel scarcity in the area, affecting the economy and sparking other issues. Therefore, safety climate and safety performance in gas stations need to be evaluated. Safety climate has been used as a tool to assess the safety performance of an organization at a given time. The aim of this study was to understand the influence of safety climate on safety performance in gas stations in Indonesia. A total of 129 gas stations were selected. To assess safety climate, a safety climate questionnaire was used, while the safety performance was captured by conducting on site structured observations. The assessment shows that gas stations have a good level of safety climate, especially when it is compared with other industrial sectors in Indonesia, such as construction. The study findings also show that safety climate has a significant positive impact on safety performance. Three safety climate dimensions with significant positive influence on safety performance are management commitment, communication, and personal accountability. Therefore, improvement efforts should focus more on these dimensions to boost safety performance in gas stations.

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1. Introduction

Accidents in gas stations may cause injury or even death to people. A recent fire in a gas station in Creeslough, Ireland, caused multiple fatalities, with 10 deaths [1]. Twenty-five gas station accidents in Indonesia were recorded in 2022, which caused two deaths and 14 people injured [2]. In February 2023, there have been two gas station fires in Indonesia. The first accident occurred in Toraja Utara Regency, South Sulawesi Province, on 7 February. A pick-up car caught fire while refueling gasoline. The driver was rushed to the hospital with burn injuries [3]. Two days later, another fire occurred at a gas station in Lembongan village, Bali province [4]. It is the only gas station in the village, which serves Lembongan and its neighbor village, Jungutbatu, with a total population of 9000 people [5]. Even though there were no injuries, the fire forced the gas station to stop operations. Thus, fuel shortage in the area was inevitable, which forced locals to buy fuel from gas station in a nearby island [6].

Apart from accidents related to fire and explosion, there are other occupational accidents in the operation of gas stations. Gas station workers are at risk of exposure to fuel inhalation and fuel contact with the skin or eyes [7]. A study by Heng et al. [8] showed that these types of accident had the second highest frequency after explosion. Other accidents include oil leakage, collision, and falls.

The gas station spread in Indonesia is not evenly distributed. In big cities, gas stations can be accessed easily, while in rural areas, one might need to travel a distance to purchase

fuel [9]. As a commodity sought by many, the availability of fuel is critical in driving the economy. A gas station fire may not only cause direct loss and injury, but also indirect losses as an effect of the difficulty of accessing fuel. Therefore, study on gas station fires and means to prevent them becomes essential.

Previous studies about gas station accidents found that the main contributor of accidents is the human factor [10]. An investigation of 120 fuel station accidents between 2016 and 2018 by Indonesia's Ministry of Energy and Mineral Resources also found three contributing factors to gas station accidents, i.e., lack of skill, culture, and competence (48%); lack of safety management (32%); and lack of engineering (20%) [11]. To address the first factor, safety climate is frequently used. Since its first appearance a couple of decades ago, safety climate has been widely studied in various fields to explain the current condition of safety culture in an organization [12]. A lot of research has been conducted in different countries, mainly the USA, Australia, and China [13]. Despite the size of the country and its economy (being the largest in Southeast Asia), research of the safety climate in Indonesia is limited. From 19 studies between 2017 and 2022, most were in the construction sector, followed by healthcare, maintenance, manufacturing, and other sectors [14]. In early 2023, two more research article were published, one in a healthcare distribution company [15] and the other concerning safety climate assessment in fuel stations in West Java [14]. Although safety climate has been used as an instrument to predict safety performance [16], studies on the relationship between safety climate and safety performance in gas stations in Indonesia, in particular, are scarce.

Considering the frequency of gas station accidents and the potential harm when such an accident happens, maintaining high safety performance in gas stations is prominent. The pathway to high safety performance will be more effective when the connection between safety climate and safety performance is well known. Therefore, it is important to conduct further investigations to see how safety climate can improve safety performance, especially in this sector.

The aim of this study was to assess the level of safety climate in gas stations in Indonesia and establish the relationship between safety climate and safety performance. The research questions that arose from this objective are:

1. What is the state of safety climate in gas stations in Indonesia?
2. What is the influence of safety climate on safety performance?
3. Which safety climate dimensions are most important in improving safety performance?

2. Literature Review

2.1. Gas Station Accident Contributing Factors

The flammable characteristic of fuels in gas stations, especially gasoline, impose risks of gas vapor release, which may lead to fatal fire [17]. Fire and explosion have been accounted as the top risk of gas station operations [18]. Most fires involve consumer vehicles [19]. Although tanker unloading was identified as the activity with most significant risk factor [20], the frequency of this activity is much less than fuel dispensing, i.e., filling fuel to consumer vehicles. In addition, fuel dispensing activity involves interaction between gas station workers and the consumer driving the vehicles, for which unsafe behaviors often occur and need to be controlled [2].

Moreover, Ahmed et al. [21] argued that even though the design, construction, and installation phases are important in building the foundations of safety in gas stations, the operation and maintenance phases are more prone to accidents. They also identified housekeeping, transportation hazard, slips, trips and falls, carelessness, fire risk, and electrical faults as potential hazards present in gas stations.

2.2. Safety Climate

Safety climate has attracted interest from safety researchers and professionals [22]. Initially, Zohar defined safety climate as the shared perception among workers on safety poli-

cies, procedures, and practices [12]. The safety climate theory has been used as a foundation in various research and practice. Studies showed that the safety climate has a positive influence in improving individual safety behavior and protecting the workforce from harm and injuries [23]. Furthermore, the use of safety climate has also extended from the personal level to a multi-level level construct, i.e., group level and organizational level [24]. This extension leads to more research in safety climate. The number of publications on the safety climate topic averaged one article per year from the 1980s to 1997. From 1998 to 2002, this number increased to four publications per year, and the number grew up to more than fifty articles per year in 2018 [25].

The increased number of studies on safety climate topics has also broadened the organization sectors involved. Most of the research can be found in the construction sector, followed by medicine sector [26]. This is not surprising because these two sectors have recorded the most accidents causing deaths and injuries [27]. Other sectors have much less exposure to safety climate study. In recent years, safety climate studies in the general oil and gas sector have been conducted in various countries, such as Norway [28,29], Denmark [30], Canada [31,32], Nigeria [33], United Arab Emirates [34], Iran [35], and Malaysia [36,37]. More specifically, in the gas station sector, there were only three publications found, two in Ghana [38,39] and the other in Indonesia [14].

2.2.1. Safety Climate Measurement

Safety climate is usually represented as a construct with several latent variables. The latent variables consist of several observed variables, which are usually in the form of questionnaire statements. To measure safety climate, a self-reported questionnaire is often used. Several known safety climate questionnaires are the Nordic Occupational Safety Climate Questionnaire (NOSACQ-50) [40] and the Safety Assessment Questionnaire (SAQ) [41]. Other researchers develop questionnaires to be more specific for their need and purpose.

Even though different questionnaires use different dimensions for explaining safety climate, six dimensions are most frequently used. These are management and supervisor commitment to safety, safety policies, resources and training, coworkers' involvement and commitment to safety, safety communication, and priority for safety [42]. In a four-scale system, safety climate score above 3.30 is considered good, between 3.00 and 3.30 fairly good, between 2.70 and 3.30 fairly low, and below 2.70 classified as low [43].

2.2.2. Safety Climate Research in Indonesia

Wibowo et al. [14] provided a list of previous safety climate studies in Indonesia, which also showed the majority of research was in the construction and healthcare industries. Research in a rock mining company studied the influence of job stress and safety climate on safety performance. It was found that safety climate has a positive relationship on safety performance, while job stress has a negative influence [44]. Wibowo et al. [14] and Yovi et al. [45] used the NOSACQ-50 questionnaire [40] to assess safety climate in gas station and forestry workers, respectively. These studies found similar results for the fifth dimension—workers' safety priority and risk non-acceptance—which showed that the majority of workers accept high-risk working conditions.

Moreover, three studies utilized the Safety Attitudes Questionnaire (SAQ) [41] to assess safety climate. Ningrum et al. [46] and Juliawati et al. [47] conducted a validity test for the Bahasa Indonesia version of SAQ, and both concluded that it had good internal consistency, validity, and reliability. Furthermore, an investigation by Indarwati et al. [48], which also used SAQ, attenuates that the staff's work experience had a significant effect on safety climate, i.e., the longer the experience, the higher the safety perceptions were on the workers. Wibowo et al. [14] also argued on this issue that less-experienced workers have higher demand in management's commitment and intervention, while experienced workers tend to accept the condition as they were accustomed to.

Another more recent reference in safety climate questionnaire development is the one from Zou and Sunindijo [49]. The questionnaire is divided into six dimensions: management commitment, safety communication, safety rules and procedures, supportive environment, personal safety involvement and needs, and safety training. The questionnaire was initially developed for the construction industry and initially tested in Australia, but it has been translated to Bahasa Indonesia and used to assess safety climate in the Indonesian construction industry by Lestari et al. [50]. The research proposed a framework for occupational health and safety performance for construction industries in Indonesia. Furthermore, by using the same framework, quantitative safety climate data were also compared between construction industries in Indonesia, Australia [51], and China [52]. The overall result showed a degree of similarity between countries, but diving deeper into the dimensions and questions, the differences become apparent. For example, in the personal accountability dimension, Australians had good personal perception on safety because the Work Health and Safety (WHS) Act 2011 regulates workforce consultation. On the other hand, workers in China do not have the option to conflict with their managers, even if things start to jeopardize safety, and Indonesian construction workers are considered informal workers and have lower education, so safety is only about following instructions.

2.2.3. Safety Climate Studies in Gas Stations

Research on safety climate in gas stations is very limited. Three research articles were found in research databases, two of them were studies in Ghana and the other in Indonesia. In their study among gas station attendants in Accra, Ansah et al. [39] stressed the importance of supervisor supports to their attendants to increase safety climate and achieve better state of safety and business sustainability. On the other hand, the study by Bakidamteh et al. [38] concerned personal proactivity in safety. Their study suggested that personnels with proactive personalities tend to exhibit a higher level of safety compliance and safety participation.

Moreover, a safety climate assessment in gas stations in Indonesia using the NOSACQ-50 questionnaire in West Java Region, Indonesia, showed that personal risk-taking behavior remains an issue to be resolved [14]. Another aspect specific to gas station safety is the involvement of the community in building safety awareness, since gas stations are usually located close to community dwellings [2].

2.3. Safety Performance

Safety performance represents how well (or poorly) an organization performs in terms of safety [23]. Although this definition is self-explanatory, scholars have proposed different approaches to measure safety performance. The most practical approach is using the lagging and leading indicators. Lagging indicators are indicators of safety performance by observing incidents after they happen. An incident could range from unsafe behaviors, near misses, injuries, and even death. These incidents are reported, and when meeting a pre-defined criterion, such as Occupational Safety and Health Authority's (OSHA) recordkeeping regulation, the incidents are recorded. Furthermore, the records (in numbers or rates) are used as lagging indicators. Some commonly used lagging indicators are Total Recordable Incident Rate (TRIR); Lost Time Case (LTC); Lost Work Day Rate (LWD); Days Away, Restricted or Job Transfer (DART); Incident Rate (IR); Severity Rate (SR); and Risk Rate (RR) [53].

On the contrary, leading indicators are measurements related to accident prevention [54]. One way to record leading indicators is by counting the frequency of several safety management efforts in preventing an incident [55]. Salas and Hallowell [56] conducted predictive validation on examples of leading indicators, which are contractor safety audit sores, frequency of safety and non-compliance observations, pre-job safety meetings, client safety walkthroughs, subcontractor safety audits, contractor leadership and clients attending orientation sessions, project risk assessments, and drug tests. Other leading indicators as

identified by Xu et al. [57] are number of safety trainings, number of risk management plans and verifications, number of closed out inspection findings, and number of learning events.

Furthermore, Ali et al. [58] divided leading indicator into two groups, i.e., driven leading indicator and observant leading indicator. Driven leading indicator is a group of safety management elements that would drive the safety performance of the workers and organization. Seven indicators are part of this group, namely, management commitment, workers' involvement, hazard identification and assessment, hazard prevention and control, training and education, evaluation and improvement, and communication and coordination. Other scholars regard these indicators as safety climate [59]. Observant indicator comprises the proximal safety antecedents (safety knowledge and safety motivation) and safety performance (safety compliance and safety participation), which are based on earlier safety performance indicators studied by Neal and Griffin [60].

Another approach in acquiring a leading indicator is by conducting direct observations. The use of standardized observation on worksite conditions and safety behaviors, such as the TR Safety Index, have been used widely in the Finnish construction industry, and the method has been proven scientifically as a valid safety indicator [61]. Furthermore, Bhagwat et al. [62] introduced a method called jobsite safety inspection (JSI) to measure safety performance in projects. By observing unsafe behaviors and unsafe conditions and addressing the issues accordingly, the safety performance will improve [63].

3. Research Method

To achieve the research objective, two main steps were taken. The first step was to conduct a safety climate assessment in the fuel stations, and the second step was to assess gas station safety performance observation. The safety climate assessment was administered using an online form, while the safety performance observation was carried out directly at the gas stations. Due to the limitations of the research resources and accessibility, convenient sampling was conveyed. A total of 130 gas stations located in three provinces in the West Java Region were selected as samples for data collection. From this number, 129 gas stations agreed to participate in the study, consisting of twenty gas stations in the Banten province, thirty-one in the Greater Jakarta province, and seventy-eight in the West Java province. The number of samples per province was proportional to the actual number of gas stations in operation in each area. All data collection was done quantitatively, and the results were analyzed using statistical computation software.

3.1. Safety Climate Assessment

The tools for assessing safety climate in gas stations for this study is derived from the safety assessment framework by Lestari et al. [50] combined with the questions from NOSACQ-50 [40]. The final questionnaire consists of forty-eight questions grouped into six dimensions, which are management commitment, communication, rules and procedures, supportive environment, personal accountability, and training. The questionnaire used a five-point Likert scale as opposed to the six-point scale used by Lestari et al. [50]. and four-point scale in NOSACQ-50 [40].

The respondents for the safety climate assessment were gas station workers of the previously selected gas stations. After receiving confirmation of participation from the gas station management, workers were asked to voluntarily fill in the safety climate questionnaire via an online platform. In total, 386 respondents participated in the safety climate assessment.

3.2. Safety Performance Measurement

For the safety performance observation to be accurate, a novel structured observation checklist was developed. The structured observation checklist was mainly derived from the gas station technical guidance published by Indonesia's Ministry of Energy and Mineral Resources [11]. Moreover, since tanker unloading, dispensing of fuel, and storage of fuel on site have been identified as the activities having the highest risk factor [20], the observation

checklist was developed specifically to focus on these areas. Observable parameters at gas stations were listed, consisting of unsafe actions and unsafe conditions, focusing on equipment and actions that can prevent gas station accidents, such as uncontrolled fuel release, fire/explosion, and sources of ignition [20]. Finally, the observation items were grouped into 5 categories based on the weight determination of hazards in fuel stations [64]. The five observation categories were Operation and Maintenance, Housekeeping, Fire and Emergency Readiness, Electrical Safety, and Behavior Control. Each of the categories had 5 observation items. The final observation checklist consisted of 25 items, as listed in Table 1.

Table 1. Observation checklist for safety performance measurement.

No.	Category	Observation Checklist Items
1	Operation and Maintenance	Fuel dispensers are equipped with breakaway coupling.
2	Operation and Maintenance	Fuel dispensers are equipped with dispensing sump.
3	Operation and Maintenance	No leak inside fuel dispensing machine.
4	Operation and Maintenance	Pipe ducting are sealed properly.
5	Operation and Maintenance	Work permits are available for maintenance work.
6	Housekeeping	No fuel spill on driveway and unloading area.
7	Housekeeping	No leak or spill in filling pot and oil sump.
8	Housekeeping	Tank sumps are clean (no fuel leak or spill).
9	Housekeeping	Dispensing sumps are clean (no leak or spill).
10	Housekeeping	Dipstick hatches are always closed.
11	Fire and Emergency Readiness	Fire extinguishers are available and ready for use.
12	Fire and Emergency Readiness	Fire extinguisher area inspected regularly.
13	Fire and Emergency Readiness	Fuel dispensers are equipped with an emergency shut down button.
14	Fire and Emergency Readiness	Emergency contact numbers are readily available.
15	Fire and Emergency Readiness	Workers have acquired fire and emergency training.
16	Electrical Safety	Grounding cables are securely fastened (in dispenser and fuel pump).
17	Electrical Safety	All cable connections are secure.
18	Electrical Safety	Electrical junction boxes are explosion proof and tightened.
19	Electrical Safety	Bonding cable is securely attached prior to fuel unloading from tank truck.
20	Electrical Safety	Electrical connection uses safe connectors.
21	Behavior Control	No cellphones in service area.
22	Behavior Control	Vehicle engines are off during gas filling.
23	Behavior Control	Safety cone placed in front of vehicles before filling.
24	Behavior Control	No unauthorized activity in the vicinity of fuel station and its surroundings.
25	Behavior Control	Safety signs and warnings correctly placed.

When conducting the observation, each item was given a score: one if the checklist item was confirmed, and zero if the observed condition differed from the checklist. The calculation of safety performance score for each fuel station was then calculated by adding the scores for each item and dividing it by the number of observation items. The value was then converted to a percentage. The higher percentage means better safety performance.

$$Safety\ Performance\ Score = \frac{Number\ of\ confirmed\ items}{Number\ of\ observation\ items} \times 100\% \qquad (1)$$

To minimize bias, the observation was done without the workers knowing they were being observed. This was done to let the workers work as they usually do, and not try to change their behavior upon observation. Only after the observation was finished did the research team approach the workers and their supervisor to inform them of the observation.

3.3. Data Analysis

After data collection had been completed, the first step was to perform data screening to remove any errors, outliers, or invalid responses. The next step was to calculate the safety climate score for each dimension by computing the average of respondents answer scores for that dimension. The safety climate score was then compared to other safety

climate scores from other literature to answer the first research question. Next, the safety performance score was calculated using Equation (1). Safety observation results were also analyzed descriptively to explore the top 10 observation findings and the number of findings on each observation category.

To explain the influence of safety climate on safety performance (the second research question) and which of the safety climate dimensions have a greater impact on safety performance (the third research question), the collected data were analyzed statistically using multiple linear regression. Regression analysis was preferred because it can predict the effect of one variable to another [65]. In previous research, this method was used to predict the relationship between safety climate and safety compliance [28], mindful safety practice [29], occupational injuries [66], and safety leadership and safety performance [67].

In this multiple linear regression analysis, the six dimensions of safety climate were set as the independent variables and the results of the safety performance score as the dependent variable.

4. Results

4.1. Safety Climate Scores

The safety climate assessment on 129 gas stations returned a mean score of 3.99 out of 5.00. This value fell slightly below 4.00, which is a good indicator of safety climate level. Management commitment and communication dimensions were the two highest scores, followed by supportive environment and training. The two dimensions with lowest scores were rules and procedure and personal accountability. The safety climate mean scores (per dimension and overall) can be viewed in Table 2.

Table 2. Safety climate mean scores.

Safety Climate Dimension	Mean
Management Commitment	4.19
Communication	4.11
Rules and Procedures	3.95
Supportive Environment	4.07
Personal Accountability	3.60
Training	4.03
Overall score	3.99

4.2. Safety Performance Results

On safety performance measurements, from twenty-five observation items, each gas station had a maximum of six failed items. The safety performance observation had a minimum score of 76%, the maximum score was 100%, and average score was 88%. While this result seems good, there were some observation items that many gas stations failed to comply with. Table 3 shows the top ten most failed items in all gas stations.

Table 3. Top ten unsafe conditions in safety performance observation.

Rank	Category	Observation Item	No. Gas Stations with Unsafe Condition *
1	Housekeeping	No leak or spill in filling pot and oil sump.	40 (31.0%)
2	Fire and Emergency Readiness	Workers have acquired fire and emergency training.	30 (23.3%)
3	Operation and Maintenance	Fuel dispensers are equipped with dispensing sump.	27 (20.9%)
4	Behavior Control	No unauthorized activity in the vicinity of fuel station and its surroundings.	26 (20.2%)
5	Electrical Safety	Bonding cable is securely attached prior to fuel unloading from tank truck.	22 (17.1%)

Table 3. *Cont.*

Rank	Category	Observation Item	No. Gas Stations with Unsafe Condition *
6	Operation and Maintenance	Work permits are available for maintenance work.	18 (14.0%)
7	Electrical Safety	Electrical connection uses safe connectors.	11 (8.5%)
8	Housekeeping	Dipstick hatches are always closed.	10 (7.8 %)
9	Fire and Emergency Readiness	Emergency contact numbers are readily available.	10 (7.8 %)
10	Behavior Control	No cellphones in service area.	10 (7.8 %)

* Number in brackets shows the percentage of gas stations with findings compared to the whole sample (129 gas stations).

Furthermore, by grouping the observation findings in all gas stations by category, the most unsafe condition was part of the Housekeeping category, followed by Operation and Maintenance. More detailed information can be observed in Table 4. The percentage shows the number of unsafe findings divided by the total number of unsafe findings in all gas stations (235 findings).

Table 4. Safety performance ranked by category.

Rank	Category	Number of Unsafe Findings	Percentage
1	Housekeeping	59	25.11%
2	Operation and Maintenance	52	22.13%
3	Fire and Emergency Readiness	46	19.57%
4	Behavior Control	41	17.45%
5	Electrical Safety	37	15.74%
	Total	235	100.00%

4.3. Safety Climate Influence on Safety Performance

Analysis of safety climate effects on safety performance was done using multiple linear regression using the software JASP version 0.16.4 (University of Amsterdam, Amsterdam, The Netherlands) for Windows [68]. The analysis used linear regression with backward iteration. In this method, initial calculation was done for all the independent variables or covariates and the software checks for covariates that had the least significant correlation to the dependent variable and removed it. This iteration was done until all the remaining covariates were those with a significant correlation to the dependent variable. Table 5 shows the modelling iteration summary.

Table 5. Multiple linear regression model summary.

Model	R	R^2	Adjusted R^2	RMSE	Durbin–Watson
1	0.675	0.456	0.429	0.540	1.919
2	0.675	0.456	0.434	0.538	1.919
3	0.673	0.454	0.436	0.537	1.932
4	0.670	0.449	0.436	0.537	1.936

In the multiple linear regression model, the final value of R was 0.670, which shows the actual safety performance scores and the predicted safety performance scores. The final value of R^2 was 44.9% while the adjusted R^2 was 43.6%. For multiple linear regression, the adjusted R^2 is preferred because it considers the predictive power of a predictor variable. In other words, the safety climate dimensions in this study accounted for 43.6% of the variance in safety performance. The value of the Durbin–Watson Statistic 1.936 indicates the correlations between residuals were low, which means the test was valid.

The next result is the Analysis of Variance (ANOVA), which provides information related to the significance of the regression model. The calculation was done for the 95% level of significance. The model is considered significant if the F-statistic value is

greater than the F-table and the p-value is less than 0.05. Based on these parameters, all models were significant as presented in Table 6. However, the F-statistic increased in each step of the iteration. The larger F-statistic value in the last model (34.007) showed it was more probable that the independent variable would have a significant effect on the dependent variable in the last model compared to the previous ones. This tells us that the final model fits better than the earlier models.

Table 6. ANOVA result.

Model		SS	df	MS	F-Table	F-Statistic	*p*-Value
1	Regression	29.797	6	4.966	2.174	17.042	<0.001
	Residual	35.552	122	0.291			
	Total	65.349	128				
2	Regression	29.791	5	5.958	2.288	20.610	<0.001
	Residual	35.558	123	0.289			
	Total	65.349	128				
3	Regression	29.641	4	7.41	2.445	25.733	<0.001
	Residual	35.708	124	0.288			
	Total	65.349	128				
4	Regression	29.367	3	9.789	2.678	34.007	<0.001
	Residual	35.982	125	0.288			
	Total	65.349	128				

Although the ANOVA result showed significance, another test was necessary to determine the significance effect of each safety climate dimensions on safety performance. Therefore, the backward iteration regression analysis was conducted. In the first model, all six covariates were included in the analysis. In the second iteration, five covariates remained—rules and procedures were omitted because it had the highest *p*-value (least significant). In the third model, the supportive environment dimension was removed from further analysis. In the last model, only three covariates remained, namely, management commitment, safety communication, and personal accountability. Since these three covariates showed statistical significance—*p* value < 0.001—then the iteration stopped, and hence the final model was obtained. The backwards iteration results can be seen in Table 7.

Table 7. Backwards iteration results on multiple linear regression modelling in JASP.

Model		Unstandardized β	Standard Error	Standardized β	t	*p*	Collinearity Statistics Tolerance	VIF
1	(Intercept)	−3.735	0.711		−5.251	<0.001		
	Management Commitment	0.467	0.154	0.255	3.028	0.003	0.629	1.590
	Safety Communication	0.496	0.245	0.214	2.025	0.045	0.399	2.504
	Rules and Procedure	0.031	0.204	0.017	0.151	0.88	0.367	2.722
	Supportive Environment	0.107	0.196	0.060	0.545	0.586	0.364	2.750
	Personal Accountability	0.472	0.142	0.266	3.329	0.001	0.698	1.433
	Training	0.16	0.184	0.087	0.872	0.385	0.449	2.230
2	(Intercept)	−3.73	0.708		−5.271	<0.001		
	Management Commitment	0.472	0.151	0.257	3.133	0.002	0.655	1.527
	Safety Communication	0.496	0.244	0.214	2.033	0.044	0.399	2.504
	Supportive Environment	0.121	0.169	0.069	0.72	0.473	0.484	2.064
	Personal Accountability	0.48	0.132	0.271	3.645	<0.001	0.803	1.245
	Training	0.163	0.183	0.088	0.891	0.375	0.452	2.214
3	(Intercept)	−3.754	0.705		−5.322	<0.001		
	Management Commitment	0.499	0.145	0.272	3.434	<0.001	0.700	1.428

Table 7. *Cont.*

Model		Unstandardized β	Standard Error	Standardized β	t	p	Collinearity Statistics Tolerance	VIF
	Safety Communication	0.561	0.226	0.242	2.483	0.014	0.463	2.158
	Personal Accountability	0.501	0.128	0.283	3.914	<0.001	0.846	1.182
	Training	0.177	0.181	0.096	0.975	0.332	0.457	2.189
4	(Intercept)	−3.775	0.705		−5.355	<0.001		
	Management Commitment	0.525	0.143	0.287	3.679	<0.001	0.725	1.379
	Safety Communication	0.691	0.183	0.298	3.785	<0.001	0.710	1.409
	Personal Accountability	0.526	0.125	0.297	4.200	<0.001	0.882	1.134

The results of this study showed that safety climate indeed had a positive influence on safety performance. However, from the backward multiple regression analysis, it showed that only three dimensions of safety climate had a significant influence on safety performance, namely, management commitment, communication, and personal accountability. The other three, i.e., rules and procedures, supportive environment, and training did not have a significant influence on safety performance. The influence of safety climate on safety performance is depicted in Figure 1 below.
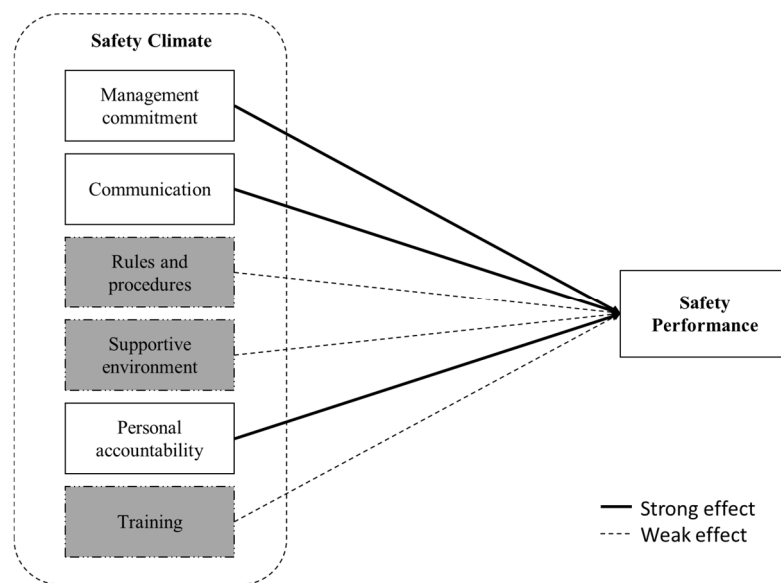

Figure 1. Final model of safety climate effect on safety performance.

5. Discussion

5.1. Safety Climate Score Analysis

The average safety climate score of all the sampled gas stations was 3.99. As can be seen in Table 8, this score is higher than other safety climate studies in the construction industry in Indonesia, which ranged from 3.14 to 3.76. The higher safety climate perception of gas station workers may be influenced by the high-risk characteristic of the workplace. Gas stations store flammable materials, which can cause fire and explosion [18]. The management team and workers in this sector are more aware that they are facing a risk of higher severity than other sectors. Moreover, in the construction sector, much of the workers have had lower educational background or no formal education [50], while gas stations are dominated by workers that are high school alumnus [14]. Educational background has been proven to significantly affect employee perception on safety [27].

Management commitment and communication were the two dimensions with the highest scores, showing that gas station owners and management have good commitment

to safety, and they can communicate safety issues well with their employees. This result is similar to other safety climate studies in other sectors in Indonesia [50,69,70]. To improve management commitment, the management team must demonstrate their commitment to health and safety by providing sufficient resources, including budget availability, and prioritize safety over production [50]. Furthermore, the management commitment must be channeled through the middle management, i.e., supervisors, and ensure that supervisors maintain a close relationship with workers because the supervisor–worker relationship has a positive influence in reducing safety violations [71].

The next two highest safety climate dimensions are supportive environment and training. A study on cross culture by Hofstede Insights reveals that Indonesia is a collectivist society, which means Indonesians prefer to act as groups, instead of as individuals [72]. This also affects the supportive environment in an organization as people tend to look out for each other. Training dimension also had a similar score of slightly above four. This shows that the workers feel they have had enough training and have been given enough knowledge to do their work. Interestingly, a study by Wibowo et al. [14] shows that more than a quarter of gas station workers in fuel stations did not receive adequate training. Therefore, this dimension still needs attention to make sure all employees receive sufficient training.

The last two dimensions that had the lowest scores are personal accountability and rules and procedures. Therefore, corrective action is required to make all rules and procedures available, easily accessible, and well understood by all gas station employees. This is an important aspect to make sure a high standard of safety is implemented during operations and get them prepared in an event of emergency. The personal accountability dimension has the lowest score, and the value is far from other dimensions, which needs to be addressed accordingly. In this dimension, it shows that workers do not really mind working in a high-risk environment. This might be affected by the high unemployment rate in Indonesia, which in August 2022 was a figure of 5.86% [73]. In this case, people would consider working at a high-risk workplace to be better than being unemployed. Moreover, the fight between operational demands and safety also has a role in personal risk-taking behavior [74]. In times when gas stations have long queues, workers tend to ignore some safety aspects so that they can work faster and serve more customers.

Table 8. Safety climate score comparison with other sectors in Indonesia.

Safety Climate Dimension	Current Study	Lestari * [50]	Kadir [70]	Sunindijo * [69]	Sunidijo * [69]
	Gas Station	Construction	Construction	Infrastructure Project	Building Project
Management Commitment	4.19	4.02	4.37	3.96	4.08
Communication	4.11	3.95	4.41	3.89	4.00
Rules and Procedures	3.95	3.52	1.95	3.38	3.64
Supportive Environment	4.07	3.50	2.03	3.42	3.57
Personal Accountability	3.60	3.62	4.44	3.60	3.63
Training	4.03	3.87	- **	3.86	3.87
Overall score	3.99	3.67	3.14	3.65	3.76

* The safety climate scores were converted from a six-point Likert scale to a five-point for comparison. ** The safety climate dimensions by Kadir et al. did not include training.

5.2. Safety Performance Analysis

From all twenty-five observation items, oil spill handling in the filling pot and oil sump area had the most finding among all sampled fuel stations. This item is part of the housekeeping category, which is considered important in establishing a safe workplace [20]. It includes maintenance and cleaning of equipment and facilities on a regular basis. In gas stations, uncleaned oil spills may form puddles of flammable material, multiplying the risk of fire. Therefore, good housekeeping programs need to be prioritized in gas station operations management, as it has been a concern in other sectors [21,57,75].

The next most prominent finding in the observation was adequate fire and emergency training. Twenty-three percent of the sampled gas stations cannot show proof of fire and

emergency training. High-risk activities such as those in oil and gas industry—including gas stations—require routine drills, exercises, and refresher trainings to ensure employees have proper knowledge to make the best decisions in emergency situations [76].

Another important finding is related to the operation and maintenance aspect. Many gas stations are unequipped with dispensing sumps—a device installed under the fuel dispenser that acts as a containment in case of spills inside the fuel dispenser—which is a critical part of the facility [77]. In addition, work permit forms were also not available in some gas stations. Without the proper procedures in place, the risk of having an accident in maintenance activity increases. Both findings are related to management commitment. If the gas station management understands the importance of operation and maintenance, they should commit to these aspects.

Other non-compliance items, such as unauthorized activity and attachment of bonding cables during fuel unloading from trucks, are related to the consistency of implementing rules and procedures in the workplace. Many oil and gas accidents were caused by violations of safety rules and procedures [28]. Violation of safety in one aspect, if not managed appropriately, may lead to other violations; therefore, corrective actions must be taken to minimize violations.

The observation method used in capturing safety performance has advantages that are not present in perception-based surveys such the methods using questionnaires [28,29,78]. First, it can capture actual conditions of safety compliance, not perception. Self-reported questionnaires are prone to bias because the participants can fill in the questionnaire based on how they want others to see them, instead of expressing their genuine thoughts or feelings [38]. Second, the recommendations after observation can be clear, without the need of complex interpretations. With clear recommendations, the organization can plan corrective actions more accurately, and improvement results can be observed immediately [62].

5.3. Safety Climate Influence on Safety Performance

Previous studies have found that management commitment has positive influence on safety performance [23,79,80]. One form of management commitment that can be sensed by workers is through the leadership of site supervisors or managers. Good leadership traits of direct supervisors can affect workers' willingness to perform better and comply to organization rules [80]. Good leaders communicate with their subordinates. They give them guides and involve them in safety discussions and decision making [81]. This involvement keeps the workers engaged and makes them feel equally responsible for workplace safety. On the other hand, unresponsible leaders create unpleasant ambience in the workplace. Leaders who fail to communicate well and create strong bonds with their employees will provoke a low-trust environment. When this is the case, it would be tough to achieve a high level of safety performance because the workers become rebellious and violate rules as an expression of dislike to their leaders.

Communication also showed positive influence on safety performance, and this dimension supports other dimensions of safety climate. As discussed earlier, management commitment needs to be communicated clearly to the workers. There are many types of communication media to choose from, e.g., verbal communication through safety talks and discussion, written communication by letters or posters, or even audio-visual through social media. The key to effective communication is to select the most appropriate means by considering the type and background (cultural and educational) [27]. Management and supervisors should also consider two-way communication with workers [2].

Personal accountability is the next dimension that has influence on safety performance. In this dimension, workers' involvement, personal responsibility, and personal perception of risk is explored. This dimension affects safety performance because it is a representation of one's values and norms, which will be manifested into action, whether it is to comply or violate safety rules. A worker may tend to comply to safety when he is positioned in a safety-strict environment but act differently in a looser environment. There is a link to

management commitment and communication. Therefore, personal accountability to safety must be developed for every person in an organization.

The three other dimensions that were not significant in influencing safety performance are rules and procedures, supportive environment, and training. An organization may have various rules and procedures in place, but going by the book again requires commitment, communication, and personal will. The same goes for training. Providing long hours of training does not change people instantly. It is the commitment of making sure improvements are made and communicating the importance of some issues that will force workers to improve in safety performance. The low influence of supportive environment on safety performance might be related to personal accountability in safety. Workers struggling with their own personal perceptions on safety might not encourage others to work safely. Nevertheless, the low effects of these three dimensions must be investigated further in future research.

6. Limitations, Implications, and Future Research

This study showed the influence of safety climate dimensions on safety performance through structured observation. Even though conducting observations gives unbiased information on what is really happening in terms of safety performance, it needs more effort. With limited resources of the research team, this study was applied to a limited number of samples and had to use convenient sampling. Furthermore, the use of observation methods as a performance indicator must be improved, for example, by doing multiple observations in one subject comparing just once as performed in this study.

This method also has its drawbacks. First, the accuracy of safety performance is highly influenced by the items used in the observation. Therefore, observation items must be formulated contentiously, and must be reviewed from time to time. Secondly, spot observations only capture the conditions in that time, and thus it may not represent the overall condition. For example, observation done at an early shift schedule might result differently compared to near the end of a shift. In this case, the workers' fatigue may affect their behavior regarding safety compliance. Third, if somehow the workers realize that they are being observed, behavior change may also occur. Therefore, these limitations must be addressed in future studies using this method.

However, this study has positive theoretical implications. The findings confirm that safety climate has a positive influence on safety performance [78] in gas stations, an area that has rarely been investigated previously. This research also proposed a new practical method for assessing safety performance. By conducting observations directly, any recommendations for improvement or correction can be more practical and less conceptual. The structured observation checklist can be used by gas station companies as a reference in conducting safety observations on their sites.

Next research should combine different methods of safety performance assessment and compare them in one study so the indicator of safety performance can be improved. Further study of safety climate and safety performance should also be made in other sectors and different regions to enrich the research field.

7. Conclusions

In this study, it was shown that the sampled gas stations had good safety climates. From the six dimensions of safety climate, management commitment, safety communication, supportive environment, and training have good scores (above 4.00). Rules and procedures barely reached 4.00, but the dimension of personal accountability fell to 3.60. This provides the knowledge that on average, gas station management already has a good commitment to safety, and they have communicated it well to the workers. The working environment between workers and their supervisors is supportive towards safety, and training has been conducted quite well. Moreover, rules and procedures are available but need more dissemination to the workers. Nevertheless, these good efforts failed to drive

the workers' inner self to comply completely with the safety standards. Therefore, more thorough evaluation is critical to increase the personal accountability dimension.

The safety performance of gas stations is also good, as can be seen from the fact that no gas station had more than six failed items in the safety performance observations. However, there were the top ten similar failed items that need to be addressed. The top three findings regarded oil-spill handling, safety training, and safety equipment. The finding in this section further supports the safety climate findings where personal accountability on safety is an issue.

Finally, after analyzing the relationship between safety climate and safety performance, it was shown that only three out of six dimensions of safety climate had a significant effect on safety performance, which were management commitment, safety communication, and personal accountability. In this case, the low scores of personal accountability dimension drags the safety performance down, although safety commitment and safety communications have been developed quite well. Therefore, a decent amount of effort is needed to align the workers' perception of safety with those of the managements and supervisors. By doing so, improvement in personal accountability might also increase safety performance.

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