Journal of Scientific & Industrial Research
Vol. 83, July 2024, pp. 782-795
DOI: 10.56042/jsir.v83i7.194

Safety Climate and Its Relationship with Workers' Risk Perceptions and Risk Tolerances toward the Acceptance of Risk Management

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Received 29 March 2023; revised 15 February 2024; accepted 13 June 2024

Risk management is a systematic approach of dealing with the inherent uncertainty of risks in a deliberate manner. Workers' risk perception and risk tolerance are two elements that may impact how a firm handles risk and how secure it is, depending on how comparable their risk perceptions and tolerances are. There exists a disparity between the phase of evaluating operational hazards and the phase of comprehending them. The role of workers towards risk management remains limited. Hence, the objective of this study is to ascertain the correlation between the perception of risk and the willingness to take risks, in connection to the workers' safety environment in refinery plants. An analysis utilising the Partial Least Squares-SEM model was performed on the data obtained from a valid research questionnaire. Results illustrate that risk perception of employees and their level of readiness to accept risks (tolerance) are remarkably impacted by the safety climate. Moreover, it explained how an individual's viewpoint on risk perception significantly impacts their willingness to embrace risk. This study increases employee awareness, which promotes a safety culture and enhances understanding of the company's risk management strategies. As a result, there will be a notable decline in occurrences pertaining to safety in general.

Keywords: Accepting hazards, Managing risk, Safe environment, Understanding of hazards, Work place

Introduction

Risk poses a threat to the organisation due to the fact that it disrupts the operation of the business. Risks manifest in diverse ways for organisations. Organisations frequently encounter a variety of risks, including but not limited to health and safety risks, environmental risks, fire risks, technical risks, extortion risks, accident and criminal risks, and so forth.[1] Risk management is an essential practice that all organisations must implement. Risk management has undergone significant development since its inception in the fields of health and safety and engineering. Presently, it finds application across various sectors, encompassing business and industry. Indeed, an increasing number of organisations are constructing risk management infrastructure both internally and in response to external legal and regulatory pressures.[2]

The current body of research on employee attitudes towards risk management remains limited, despite the rapid development and evolution of the fields of leadership development, facilitation, application, and enhancement.[3–5]

The literature on risk management in Malaysia reveals that academics and policymakers have focused on technical aspects of risk management and leadership rather than employees' roles.[6–8] Success in risk management relies on unseen but crucial employees. Insufficient or no knowledge regarding the safety process and requirements, workplace constraints, state regulations, worker participation, risk management practices, and other relevant aspects can detrimentally affect an individual's comprehension of risk management. These issues may result in significant financial and safety concerns for the organisations. Additionally, front-line employees of the organisation are in direct exposure to occupational risks, including injuries, incidents, and hazards. According to Didla *et al.*[9], workers can take measures to protect themselves from potential hazards if they believe their employment poses such risks. Their likelihood of being injured or involved in an accident at work increases if they engage in hazardous behaviour.[10]

Implementing robust safety or risk management systems in organisations, particularly those of significant size, is increasingly mandated by law rather than being only an ethical obligation. The

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purpose of this is to ensure the safety and well-being of the personnel.[11] Both employers and workers are significant contributors to risk and play a crucial role in a policy of risk management. Human risk management involves ensuring the safety, well-being, and productivity of all employees inside a corporation.[12] In the field of risk management, it is common for managers and staff to lack sufficient knowledge about risks and fail to effectively communicate information within their organisations, resulting in a lack of proactive risk control measures prior to accidents occurring. As a result, there is a mismatch between the stages of measuring operational risks and comprehending them. Thus, mishaps are quite probable.[1]

Based on relevant research of Ricciardi and Rice, risk management mainly revolves on the assessment of risk and the level of risk that an individual or organisation is willing to accept.[13] Risk perception entails the recognition of potential hazards originating from either persons or the surrounding environment. Risk perception is a multifaceted concept that influences behaviour and is influenced by emotional attitudes (such as fear and guilt), cognitive processes (such as decision-making), and social predictions (such as social confidence).[14,15] Risk tolerance is typically associated with an individual's mood or inherent character qualities.[16] Risk tolerance is a psychological characteristic that governs an individual's willingness to tolerate a certain level of risk in order to attain a certain objective.[17] Comprehending risk influences how one perceives and tolerates danger. Hunter[18] states that risk perception and risk tolerance are interconnected and often perplexing constructs, yet both might impact one's propensity for engaging in dangerous conduct. Knowledge, feelings, and experience combine to generate "risk perception," which, according to Roszkowski and Davey[17], provides significance to an objective. Workers who have a holistic picture of workplace danger are more inclined to prioritise safety. Maiti *et al.*[19] suggest that safety experts should consider risk tolerance as those who are more inclined to take risks are more prone to experiencing accidents. The workers' perception and tolerance of risk have a psychological influence on the organization's risk management system.[20,21]

According to Glendon *et al.*[3], it is advisable to incorporate risk management into safety programmes with other organisational objectives. Additionally, they suggest employing commitment-based human resource strategies to inspire and incentivize personnel. This process methodically discovers and evaluates potential dangers inside a company. Gillen *et al.*[22] and Nordlöf *et al.*[23] discovered that the absence of a connection between safety and productivity impeded the progress of safety efforts. Thus, the safety culture of any firm originates from the implementation of exceptional safety principles.

Based on relevant research, establishing a safety culture is essential for ensuring the long-term viability, effectiveness, and high performance of risk management systems. This is because a safety culture fosters the development and perpetuation of safety-focused attitudes and behaviours. Firms that have a strong safety culture tend to see improved performance in their management practices. The risk management framework encompasses strategic risk management and stakeholder participation. Regrettably, there is an excessive focus on senior management's participation in risk management, leading to a neglect of each individual's duty to acquire, apply, and cultivate sound risk-taking skills.[24]

The assessment of employee safety perceptions in the safety culture is based on corporate ideals and assumptions, rather than individual personal perception. In comparison to implicit safety culture, safety climate can be intentionally measured.[25] According to Flin *et al.*[26], the safety climate is seen as a temporary aspect of the safety culture from the employee's perspective. Measuring safety climate provides insights into the safety status and culture of the organisation.[25] Zohar[27] states that safety culture reflects the true emphasis on safety within an organisation. Griffin and Curcuruto[25] provided a definition of safety climate as descriptions based on employees' experiences and reports in actual organisational settings. A study conducted by Mearns *et al.*[28], has suggested that the safety climate could serve as an indicator of the safety culture within an organisation, as expressed through employees' actions and attitudes towards safety. According to Glendon *et al.*[3] safety culture extends beyond the safety climate. The document outlines important elements of the organization's present condition, including the overall quality of its internal environment.

A study conducted by Garcia *et al.*[29], has shown that employees who lacked understanding of their company's safety climate were more inclined to engage in risky behaviour and violate safety protocols. Rundmo[30] observed that the safety climate, employee attitudes towards safety and accident prevention had an impact on workplace risk behaviour. The primary markers of risk perception are anxiety and employee safety. He cautioned against evaluating the risk perception model without determining the safe climate. The safety climate has the potential to influence the level of risk that employees are willing to tolerate and their perception of the likelihood of injuries and accidents.[31] Oah *et al*.[32] (cited in Mearns and Flin,[33]) discovered that the safety climate and working conditions inside an organisation have an influence on employees' perception of risk. A conducive safety environment decreases the level of risk that workers are willing to tolerate.[31,34]

As such, this study aims to determine if a company's safety climate may enhance workers' understanding of risk management by assessing their risk perception and tolerance. This study also investigates the role of worker risk perception in mediating the connection between safety climate and risk tolerance at two refineries located on the west coast of peninsular Malaysia (Fig. 1). The oil and gas industry's capacity to function efficiently in scenarios with acceptable risks and hazards is mostly reliant on safety measures. Typically, violations of safety rules and procedures are often identified as a contributing cause that results in accidents and other anticipated consequences. Therefore, possessing a comprehensive comprehension of efficient risk management techniques to enhance adherence to safety regulations and protocols is vital. Hence, two refinery plants were selected as a case study to evaluate the research goals of the study, since it demonstrates a robust and dependable implementation of safety culture and risk management.[35,36] The study aimed to evaluate three hypotheses.

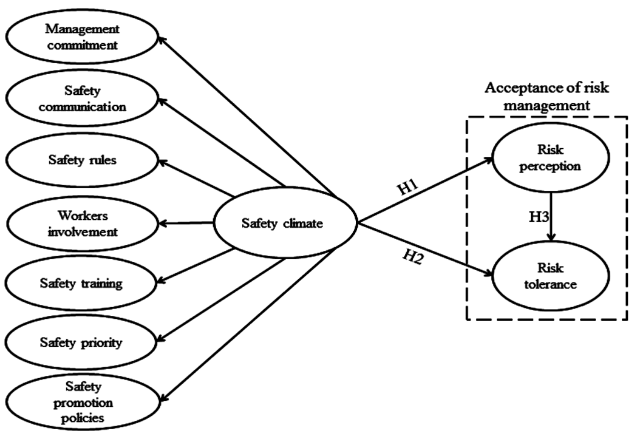

Fig. 1 — Research model

Hypothesis 1: Safety climate has positive impact on workers' risk perception in study refinery plants.

Hypothesis 2: Safety climate has negative impact on workers' risk tolerance in study refinery plants.

Hypothesis 3: Risk perception significantly mediates and negatively impacts the relationship between safety climate and workers' risk tolerance in study refinery plants.

Material and Methods

Research Instrument

Safety climate refers to the overall perception of safety among employees. It is often measured via employee questionnaire surveys to assess their perspectives on safety.[37] According to Choudhry *et al*.[38], the safety climate questionnaire is utilised to gather employees' perspectives on management's dedication to safety or to pinpoint safety concerns that need to be addressed. Since this approach to gathering data has been effective in the past, it employed in this investigation. The research variables were divided into two segments according to the study framework. The term "safety climate" referred to an external variable consisting of 7 distinct elements. These parameters were chosen based on the requirements of the study and the extent of the investigation, following extensive discussions with top management and safety officials of the organisation being investigated. Existing literature demonstrates that several surveys have been created with the aim of identifying the fundamental elements that constitute safety climate. The premise is that variations in management style and safety legislation among organisations lead to distinct safety perceptions, which in turn manifest in diverse factor structures. The differences in factor structures are most likely a result of the specific questions included in different surveys, the diverse samples utilised, and the varying methodologies employed by different researchers.[39] The endogenous variable "acceptance of risk management" is comprised of two elements in the second half of this study. The survey included a five-point Likert scale ranging from 1 (indicating strong disagreement) to 5 (indicating strong agreement). Prior to analysis, the negative items of the instrument were reversed. Two executives and two senior safety officers assessed the instrument to confirm its face validity, resulting in specific adjustments to the instrument. Questions having a loading value less than 0.5 were excluded from further analysis in this study.[40] The final questionnaire for this study consisted of 45 items. The questions in Table 1 were developed using research conducted by Mearns *et al*.[41], Cox and Cheyne[42], Vinodkumar and Bhasi[43], Oah *et al*.[32], and Bhandari *et al*.[44] with minor modifications (Table 1).

Sampling Methods and Data Collections

A sampling method with two stages was utilised. Two petroleum companies were chosen for the study using purposive sampling in the peninsular Malaysia, taking into account demographic factors, business size, scope of activity, and research objectives. Furthermore, a total of 100 questionnaires were delivered in a random manner to administrators, safety officials, supervisors, and workers of either refinery (about 1/3 of each refinery's population). The questionnaire was distributed and collected in person. Data gathering takes place for one week at each facility. This study investigated the impact of safety climate on workers' willingness to adopt risk management strategies, specifically focusing on two factors: risk perception and risk tolerance. The study specifically underlined the importance of front-line operators and technicians, since they were found to be more highly regarded than supervisors, managers, or higher-level personnel. Out of the 111 questionnaires that were considered legitimate, 81 were chosen for analysis based on the study aims. Among these, 45 questionnaires were from refinery A and 36 were from refinery B.

Methods to Measure Relationship (SEM)

Structural Equation Modelling (SEM) is a statistical technique that enables researchers to concurrently examine intricate correlations among several variables. This tool is robust and can be utilised for both confirmatory factor analysis and path analysis. Variance-Based Structural Equation Modelling (SEM), also known as Partial Least Squares-SEM (PLS-SEM) or Covariance-Based SEM (CB-SEM), are two widely used methodologies in the field of SEM.

CB-SEM utilises the covariance matrix of observed variables to assess the magnitude of connections between latent variables. It achieves this by optimising the agreement between the observed data and the theoretical model. It is extensively utilised in the field of social sciences and has a lengthy record of advancement. Conversely, VB-SEM relies on the variance-covariance matrix of the observed variables and determines the extent of connections between latent variables by maximising the explained variance of the model. This technique is predominantly employed in the disciplines of engineering, computer science, and business.

The main difference between CB-SEM and VB-SEM is the way they estimate the relationships among the latent variables. CB-SEM is based on the covariance matrix, whereas VB-SEM is based on the variance-covariance matrix. However, there are some advantages to using PLS-VB SEM that may make it a better choice for certain research questions or data types.[45]

1. Small sample sizes: PLS-SEM can handle small sample sizes more effectively than CB-SEM, making it a better choice for studies with limited data.
2. Non-normal data: PLS-SEM is robust to non-normal data, whereas CB-SEM requires that data be normally distributed.
3. Complex models: PLS-SEM can handle complex models with many latent variables and indicators, making it a better choice for studies that involve multiple constructs or dimensions.
4. Predictive modeling: PLS-SEM is better suited for predictive modeling, as it focuses on explaining the variance in the dependent variables rather than testing specific hypotheses.
5. Formative measurement models: PLS-SEM is better suited for formative measurement models, which posit that the observed indicators define the latent construct, whereas CB-SEM is better suited for reflective measurement models, which posit that the latent construct defines the observed indicators.

The benefits previously mentioned were the basis for using PLS-SEM to investigate the relationship between the latent variables (safety climate, workers' perception of risk, and risk tolerance). PLS-SEM is composed of both exterior and inner models. The outer model, also known as the measurement model, illustrates the relationship between observed variables, sometimes called indicators, and underlying factors known as latent variables. (constructs). It reflects the extent to which variables measure latent constructs. The outer model is evaluated using loadings, which display the strength of the indicator-construct connection. The structural model, also

Table 1 — Questionnaire items with loading factors

Codes	Factors	Loadings
	Management Commitment	
MC1.	At my workplace, management will take swift action to correct safety issues	0.834
MC2.	At my workplace, the manager / supervisor showed an interest in my safety	0.735
MC3.	Management regularly consults employees on workplace health and safety issues	0.750
MC4.	At my workplace, management turns a blind eye to safety issues	0.912
MC5.	Managers only take action after an accident	0.752
	Safety Communication	
SCO1.	My supervisor and I openly discuss on labour issues	0.891
SCO2.	Talking to workeris common when changes in work practices are recommended	0.917
SCO3.	Workers are effectively receiving company policy	0.839
SCO4.	My manager / supervisor always informs me of latest safety information	0.854
SCO5.	Workers are encouraged to support and look out for each other	0.884
	Safety training	
ST1.	I believe our company provides workers with full training on workplace health and safety issues.	0.851
ST2.	I acknowledge that the new hires have received enough training to learn the safety rules and procedures	0.847
ST3.	I believe that safety matters have a great priority in the training program	0.923
ST4.	I feel that the safety training I have received is sufficient to assess hazards in the workplace	0.868
ST5.	I acknowledge that company training facilities and materials are in good condition	0.896
ST6.	I believe that my company strategy is essential to inspire workers to support others in using safety practices	0.872
	Safety Rules	
SR1.	Safety rules are always practical	0.796
SR2.	I can follow safety rules without conflicting with work practices	0.907
SR4.	Safety rules and procedures are always up to date at workplace	0.539
SR5.	I think some safety rules and procedures are impractical at workplace	0.820
SR7.	Sometimes safety requirements need to be exceeded in order to complete work faster	0.754
	Workers Involvement	
WI1.	I am involved with informing the important safety issues to the manager	0.858
WI2.	I am involved with daily health and safety issues at workplace	0.905
WI3.	I think the mission and purpose make me feel the importance of my job	0.930
WI4.	I am determined to do my best in identifying safety problems at work	0.905
WI5.	Before making a final decision on safety-related matters, management always welcomes the opinions of employees	0.849
WI7.	Ido not seriously contribute in identifying safety problems	0.791
	Safety Priority	
SPR1.	I think management clearly believes that employee safety is very important	0.640
SPR2.	I don't think safety issues have a high priority	0.797
SPR3.	I acknowledge that safety strategy are carefully followed	0.885
SPR4.	I think management believes that safety is as important as production	0.841
SPR5.	I think to increase the production we can compromise on safety	0.714
	Safety promotion policies	
SPP1.	In my company, promoting and improving safe behaviour are considered positive factors for job promotion	0.872
SPP2.	In my company, reporting safety hazards have reward for workers	0.775
SPP3.	In my company the safety promotional activities organized by the management is very useful in improving the safety awareness of the workers	0.845
SPP4.	In my company, employees have very healthy cooperation to detect and report unsafe action and condition	0.820
SPP5.	In my company, management implements an open-door policy for safety issues	0.785
	Risk perception	
RP1.	I am always aware about any types of work injuries in my workplace	0.728
RP3.	I know that the chances of being involved in an accident are quite high in my workplace	0.808
RP4.	I acknowledge the conditions here helps me to prevent risks	0.901
RP5.	I always consider my decision carefully before doing any risky action	0.664
	Risk tolerance	
RT1.	I feel sometimes need to take risks to get the job done	0.849
RT2.	I like to do two things (works) at the same time at work (multitasking)	0.794
RT3.	I prefer safely skip unnecessary steps to settle the job done faster	0.731
RT4.	I like to distract my colleagues while we are working on a task	0.662

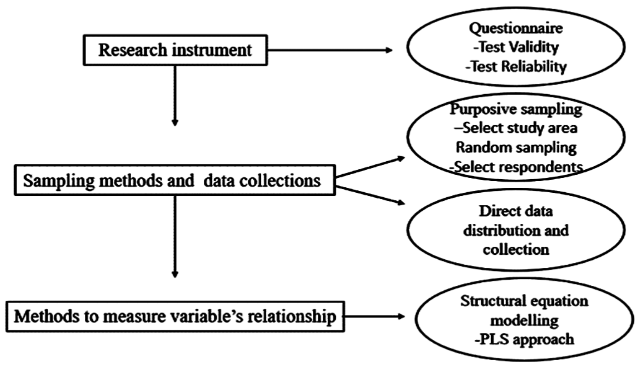

Fig. 2 — Methodology flowchart

known as the inner model, elucidates the connections between latent variables. It describes the manner in which the constructs influence the dependent variable. Path coefficients are utilised to evaluate the inner model. PLS-SEM simultaneously evaluates both the outer and inner models.

A reflective formative structural equation model was established. In a reflective measurement model, the observed variables, also known as indicators, are considered to be a reflection of the underlying latent variable. The initial structural model investigated the direct influence of safety climate as a second-order independent (exogenous) latent variable on workers' risk perception and risk tolerance as two dependent (endogenous) latent variables. To accomplish the research aims, the second structural model looked at "risk perception" as a mediator between the worker's risk tolerance (dependent variable) and the safety climate (independent variable).

Effect size in PLS-SEM pertains to the magnitude of the associations between the latent variables in the inner model and the observable variables in the outer model. The effect size quantifies the extent of the association between the variables and can be employed to assess the real-world importance of the results. Effect size is a crucial factor in PLS-SEM as it contributes in determining the practical significance of the findings. Significant impact sizes indicate that the findings are substantial and have practical consequences, whereas insignificant effect sizes show that the findings may not be practically meaningful. Nevertheless, it is crucial to constantly take into account the research issue and theoretical framework of the study when interpreting the effect size. The following flowchart outlining the methods is used in the study (Fig. 2).

Table 2 — Research variables mean and standard deviation

Research variables	Mean	St. D	Min.	Max.
Safety climate	4.42	0.27	3.63	5.00
Risk perception	4.65	0.35	3.40	5.00
Risk tolerance	1.25	0.29	1.00	2.40

Results

The data was analysed using quantitative methods. In summary, descriptive statistics were conducted for the survey items. The provided table displays the average and standard deviation outcomes for separate components (safety climate) and outcomes (risk perception and risk tolerance) (Table 2).

Measurement (outer) Model

Verification of the construct validity of the measurement (outer) model was performed. The construct validity of the study was evaluated using convergent and discriminant tests, which involved assigning specific questions to theoretical constructs. Calculations were performed to assess the convergent validity and internal consistency of the variables. The Average Variance Extracted (AVE), roh-A, Composite Reliability (CR), and Cronbach's Alpha were determined for each latent construct. All construct Average Variance Extracted (AVE) values must be greater than 0.5.[(46)] Prior research suggests that to ensure instrument reliability, it is advisable to use a roh-A, composite reliability (CR), and Cronbach's Alpha level of 0.7 or higher.[47] The item values in Table 3 surpassing the thresholds, which confirms the convergence validity of the study model. The results confirm the validity and internal consistency of the measurement model.

Evaluating the discriminant validity of latent constructs was another aspect that was taken into consideration. Discriminant validity examines if the structural equation model accurately represents distinct latent variables in the data. The discriminative validity in PLS-SEM (HTMT) may be quantified using AVE and Heterotrait-Monotraitratio. Fornell and Larker[47] provided a definition for discriminant validity, stating that it is achieved when the square root of the Average Variance Extracted (AVE) for each component is greater than the correlation with the other components. The HTMT validity is below 0.85.[48] Results in Table 4 indicates that AVE's bold square root values are greater than the correlations under them.

The study constructs of the PLS-SME were recognizable and irrelevant from each other as

Table 3 — The Convergent Validity result of overall measurement model

2nd Order Constructs	AVE	CR	1th order constructs	AVE	CR	rho-A	Cronbach's Alpha
Safety Climate	0.825	0.937	Management Commitment	0.639	0.898	0.888	0.860
			Safety Communication	0.770	0.944	0.931	0.925
			Safety Training	0.768	0.952	0.939	0.939
			Safety Rules	0.597	0.878	0.859	0.823
			Workers Involvement	0.764	0.951	0.939	0.938
			Safety Priority	0.609	0.885	0.865	0.835
			Safety Promotion Policies	0.673	0.911	0.885	0.878
			Risk perception	0.609	0.860	0.792	0.779
			Risk tolerance	0.586	0.850	0.777	0.766

Table 4 — Fornell–Larcker criterion test

	MC	RP	RT	SCO	SP	SPP	SR	ST	WI
Management commitment	**0.799**								
Risk perception	0.401	**0.780**							
Risk tolerance	−0.222	−0.507	**0.766**						
Safety communication	0.761	0.395	−0.215	**0.877**					
Safety priority	0.378	0.670	−0.670	0.347	**0.780**				
Safety promotion policies	0.547	0.614	−0.380	0.632	0.569	**0.820**			
Safety rules	0.516	0.524	−0.636	0.478	0.642	0.548	**0.773**		
Safety training	0.428	0.387	−0.253	0.343	0.489	0.652	0.329	**0.876**	
Workers involvement	0.603	0.618	−0.408	0.514	0.627	0.706	0.674	0.464	**0.874**

Note; MC: Management commitment, RP: Risk perception, RT, Risk tolerance, SCO: Safety communication, SP: Safety priority, SPP: Safety promotion policies, SR: Safety rules, ST: Safety training, WI: Workers involvement

Table 5 — HTMT test of discriminant validity

	MC	RP	RT	SCO	SP	SPP	SR	ST	WI
Management commitment	**1**								
Risk perception	0.463	**1**							
Risk tolerance	0.325	0.644	**1**						
Safety communication	0.838	0.465	0.274	**1**					
Safety priority	0.392	0.818	0.833	0.376	**1**				
Safety promotion policies	0.586	0.751	0.446	0.689	0.652	**1**			
Safety rules	0.581	0.655	0.808	0.515	0.762	0.640	**1**		
Safety training	0.451	0.456	0.290	0.360	0.550	0.700	0.358	**1**	
Workers involvement	0.630	0.723	0.473	0.541	0.694	0.776	0.747	0.490	**1**

Note; MC: Management commitment, RP: Risk perception, RT, Risk tolerance, SCO: Safety communication, SP: Safety priority, SPP: Safety promotion policies, SR: Safety rules, ST: Safety training, WI: Workers involvement

Heterotrait-Monotrait ratios of the outer and inner models were below the threshold (Table 5).

This study successfully demonstrated the evaluation of cross-loading standards and the discriminant validity of the measurement model (outer model). Therefore, the theoretical model was confirmed to be valid using convergent and discriminant validation, and it provided support for the study model.

Structural (inner) Model

Once the validity and reliability of the structural measurements have been confirmed, it is now necessary to assess the results of the inner model. The structural model represents the internal structure of the research model, including its components and latent variables.[49] Goodness-of-fit metrics, such as the R-squared and Q-squared values, can be employed to evaluate the degree to which the internal model accurately corresponds to the data. The R-squared value quantifies the proportion of variability in the dependent variables that can be accounted for by the independent variables. The Q-squared value is a variant of the R-squared value that is obtained by cross-validation and serves as an indicator of the model's predictive capability.

Therefore, while analysing the structural model in PLS-SEM, it is essential to consider path coefficients,

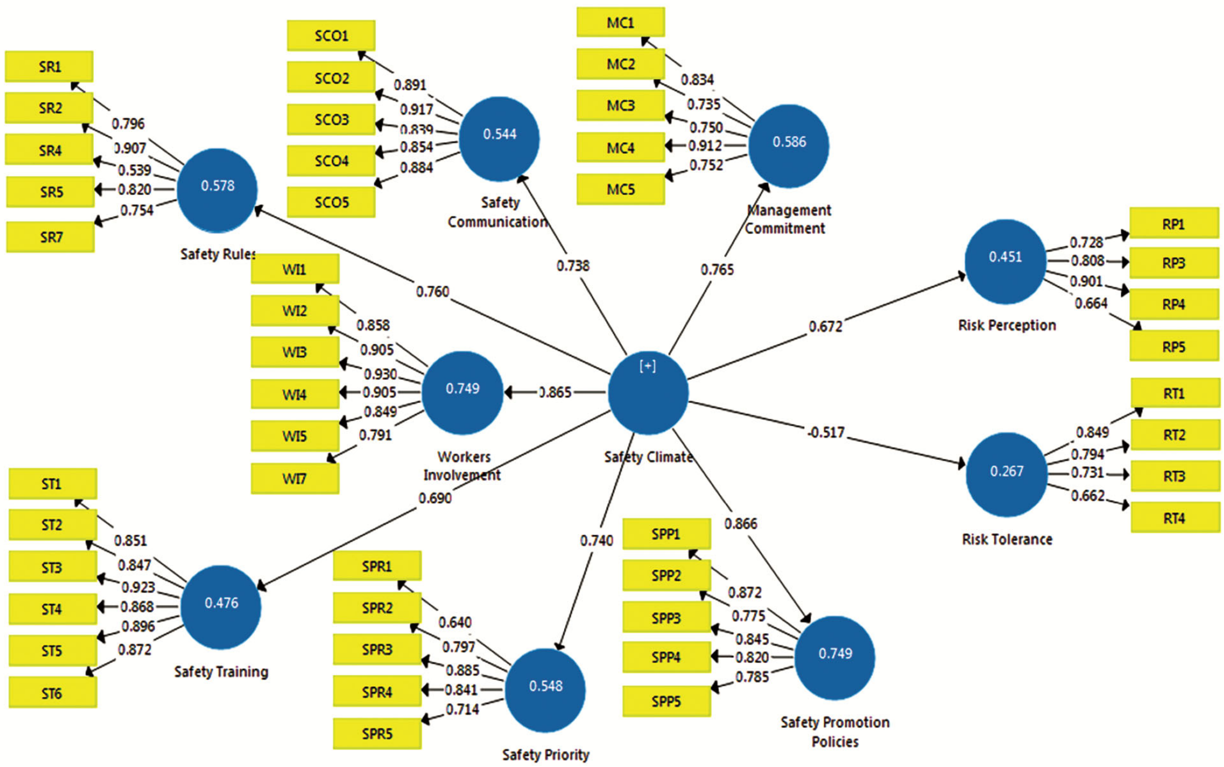

Fig. 3 — Path models of factor affecting on acceptance of risk management

R2 values, f2 impact size, predictive relevance (Q2), and q2 effect size.[45] When evaluating the outcomes of a structural model, it is important to consider and solve the issue of collinearity, also known as Variance Inflation Factor (VIF). The VIF values were much lower than 4, as reported by O'brien in 2007.[(50)] VIF values for safety climate and risk perception toward risk tolerance were 1.811 and 1.810 respectively. Therefore, there is no presence of predictor construct collinearity in the structural model.

The R^2 values of the dependent latent variables were computed during the evaluation of the structural model. The coefficient in question is a measure of model accuracy, calculated by taking the correlation between the actual and projected values and squaring it. The statement refers to the proportion of variance in the dependent variable that may be attributed to the independent variable.[51] The R^2 values of 0.75, 0.50, or 0.25 for dependent constructs are considered significant, moderate, and low, respectively, based on the specific pattern and field of research.[45]

Following the recommendations outlined by Hair *et al.*[45], the initial structural model (Fig. 3) without a mediator showed that the R^2 values for the dependent constructs of risk tolerance (0.267) and risk perception (0.451) were quite low. These findings suggest that the safety climate can account for just 26.7% of the variability in risk tolerance and 45.1% of the variability in risk perception.

A value of 0.307 was determined for the unobserved factor of risk tolerance in the inner path model with mediator (Fig. 4). This study illustrates that the concepts of safety climate and risk perception, which are separate factors, accounted for 30.7% of the variation in risk tolerance. The impact of safety climate on risk tolerance was 4% higher than its direct effect. This suggests that approximately 30% of the risk tolerance was derived from the seven sub-latent constructs of safety climate and risk perception found in the model.

Following the calculation of the path estimation, a bootstrap analysis was conducted to assess the statistical significance of the path coefficients in the structural model. The outcomes of the bootstrapping process are displayed in Table 6.

The preliminary structural (inner) model, which did not include a mediator, demonstrated that safety climate had a significantly positive impact on worker risk perception ($B = 0.672$, $P < 0.01$). At $\alpha = 1\%$, therefore, hypothesis 1 is accepted. Additionally, the model illustrated a significant direct inverse

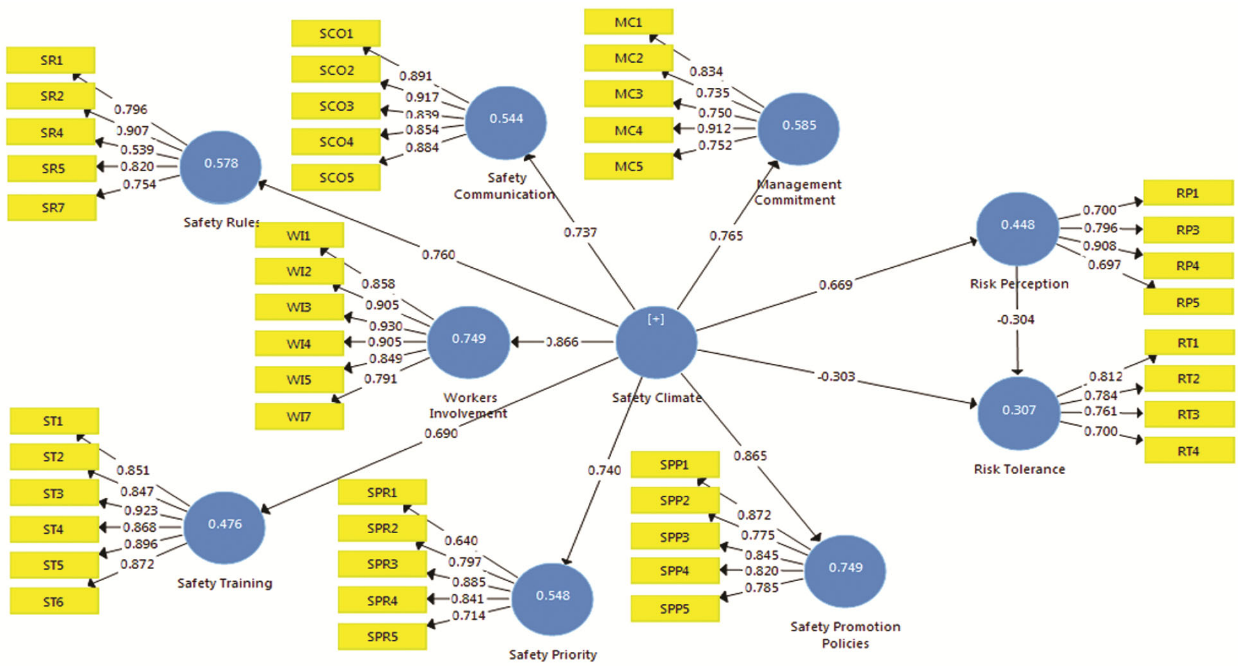

Fig. 4 — Path models of factor affecting on acceptance of risk management (with mediator)

Table 6 — Results of the structural model Path Coefficients

Hypothesise	Relationship	Standardize Beta	Standard deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	95.00% CI LL	95.00% CI UL
H1	Safety climate -> Risk perception	0.672	0.057	11.822	0.000	0.559	0.785
H2	Safety climate -> Risk tolerance	−0.517	0.096	5.368	0.000	−0.708	−0.326
H3	Safety climate -> Risk perception	0.669	0.054	10.527	0.000	0.522	0.773
	Risk perception-> Risk tolerance	−0.304	0.144	2.104	0.036	−0.550	0.027
	Safety climate -> Risk tolerance	−0.303	0.170	1.777	0.076	−0.589	0.082
	Safety climate -> Risk perception-> Risk tolerance	−0.203	0.098	2.068	0.039	−0.367	0.057

Note: P value is significant at 0.1

correlation between safety climate and worker risk tolerance (B = −0.517, $P < 0.01$). Thus, at α = 1%, hypothesis 2 remains valid.

Safety climate and risk tolerance were mediated by risk perception in the inner path model with mediator. However, despite the marginally stronger negative mediating effect of risk perception (B = −0.304, $P < 0.05$), sufficient evidence remains to support the notion that risk tolerance is directly influenced by the safety climate (B = −0.303, $P < 0.1$). Therefore, since risk perception partially mediates the relationship between safety climate and risk tolerance at α = 10%, hypothesis 3 is supported.

An assessment of effect size was then conducted. In practice, the degree of influence of the relationship between constructs determined the practical importance of significant effects. The f^2 assesses the influence of each self-contained latent construct on the dependent construct. The degree to which the removal of an independent construct from the path model impacts the latent dependent construct can be evaluated by examining the variation in the R^2 value, which represents the coefficient of determination. f^2values varied between 0.020 and 0.150, 0.150 and 0.350, and 0.350 and above, indicating an effect size that are either small, medium, or large.[52] Each

Table 7 — Results of effect size f^2 for exogenous latent constructs

Effect size(f-sq)

Predictor	Endogenous	R-Sq included	R-Sq excluded	Effect size	Effect
Safety climate	Risk tolerance	0.307	0.281	0.0375	Low
Risk perception	Risk tolerance	0.307	0.267	0.0577	Low

Table 8 — Results of predictive relevance q^2 for exogenous (independent) latent constructs

Predictive Relevance (q-sq)

Predictor	Endogenous	Q-Sq Included	Q-Sq Excluded	Predictive relevance	Predict
Safety climate	Risk Tolerance	0.155	0.141	0.0165	Small
Risk perception	Risk Tolerance	0.155	0.132	0.0272	Small

exogenous latent component's $f^2$is presented in Table 7.

In this investigation, PLS models were evaluated utilising the Stone-Geisser test (Q^2 values). In order to evaluate model fit in PLS analysis, this test can be applied to R^2 values.[53] It appears from Q^2 that the theoretical model is capable of forecasting individual latent constructs. Higher values of Q^2 in the PLS model indicate greater predictive power.[40] In this study the Q^2 was over the threshold (Q^2 = 0.155), confirming the path model's prediction relationship for endogenous (dependent) constructs (Risk Tolerance).

However, q^2 examines the impact of the predictive significance of the exogenous variable rather than the magnitude of the relationships between the constructs. As a result, the criteria used to evaluate the effect size of q^2 are identical to those used for assessing the effect size of f^2. The q^2 values for each exogenous construct that was taken into account presents in Table 8.

The results obtained indicate that safety climate and risk perception had minimal impact on the predictive significance of risk tolerance.

Discussion

This research examined the risk management programmes of two refinery plants, both of which adhered to the MS ISO 31000:2010 standard. The reference given is from the Department of Standards Malaysia in 2010.[(54)] Risk management include the activities of establishing, evaluating, addressing, monitoring, evaluating, communicating, and seeking advice. Andersen and Terp[55] state that risk management serves to remove, minimise, and control risks, enhance returns, and prevent speculative hazards. Risk management is to mitigate losses and optimise profits. Significant risk has a negative impact on the cost, quality, time, and performance of a system. Risk perception and tolerance refer to an individual's assessment of the likelihood of unintended outcomes, such as injuries, accidents, illnesses, and losses. The level of perceived risk and tolerance can vary depending on the specific type of risk. This variation has been observed in studies conducted by Kirschenbaum *et al*.[56], Wang *et al*.[57], and Oah *et al*.[32]. Hence, the assessment of firm risk management adoption is influenced by the worker's perspective and tolerance towards risk. Creating a secure environment might enhance employees' perception of potential hazards. This study investigated the impact of safety environment on the risk perception and tolerance of frontline workers in two refinery facilities. It also explored the role of risk perception in mediating the link between safety climate and risk tolerance.

The employees' compliance with the organization's risk management programme had an indirect impact on their risk perception and tolerance due to their perception of a positive safety climate. Therefore, employees are more inclined to engage in risk management when they perceive that their organisation has a positive safety climate. This was in regard to the safety climate and its various components. The safety climate was examined in relation to management commitment, safety communication, safety training, safety regulations, employee participation, safety priority, and safety promotion policies. An organization's risk management system could be enhanced by strong performance in the aforementioned areas.[58,59] As a result, by comprehending these attributes, individuals' risk tolerance and perception regarding corporate risk management can be enhanced.

Safety climate had the anticipated upward effect on employees' risk perception and the opposite effect on their risk tolerance. While safety climate has historically been conceptualised and operationalized at the organisational level, there is growing evidence suggesting that safety climate information and its predictive capabilities can be observed at both the individual and work group levels.[60] Specifically, employees became more receptive to risk management as their awareness of the benefits and advantages of safety climate increased.[61] In fact, it is effective when personnel within an organisation are attentive of the risk exposure. This initial discovery validates the results of additional research that established a positive association between perceived risk management and the safety climate at the workgroup and individual levels.[62,31] Hence, the level of staff awareness regarding the risk management practices of their organisation may contribute to their heightened concern regarding safety matters.

This study provides further support for the findings of Ken and Alan[4] that the risk perception of construction workers is positively influenced by the safety climate of the workplace: a stronger safety climate corresponds to a larger risk perception. The significance of fostering a safety climate is underscored in their study, as it impacts the risk management perceptions of construction workers.[4] Pandit *et al*.[5] discovered that construction workers had greater risk awareness and risk perception in environments with a positive safety climate. An empirical correlation of significant magnitude has identified by Johari *et al*.[63] between safety climate and apprehensive behaviour among employees of manufacturing companies. In addition, they discovered an inverse correlation between a positive safety climate among employees and unsafe behaviour. Therefore, safe behaviours are more likely to be encouraged in a workplace with a strong safety climate, which may boost employees' risk perceptions.

Elmoujaddidi and Bachir[34] discovered that a robust safety climate counteracts the adverse consequences of a high tolerance for risk on safety behaviour. The presence of a safety-oriented environment might decrease the willingness to take risks in the field of occupational safety and workplace risk management. Low *et al*.[64] investigated the propensity of workers to engage in risk-taking behaviour. The practical conduct of construction workers had adversely correlated with the safety climate, but not with the risk-taking behaviour.

This study posits, on the basis of survey findings and pertinent scholarly works, that in organisations with comparable cultures, the safety climate serves as a precursor to the risk management parameters under investigation, namely risk perception and risk tolerance. Employee motivation and knowledge are impacted by risk management, which increases safety.[65] It was anticipated that a safety climate would enhance employees' risk perception. Consequently, a favourable safety climate has the potential to inspire better safety practices and employee conduct that promotes health and safety and advances the organization's objectives is reflected in the way risks are perceived.[66] Nonetheless, risk tolerance among employees has adversely affected by risk perception promotion (mediator). This research validates the conclusions drawn by Low *et al*.[64] regarding the adverse influence of risk perception on worker hazard behaviour. According to Li *et al*.[67], the most detrimental effect on safety risk perceptions is risk tolerance. Employees frequently accept extremely hazardous situations to the extent that they are willing to violate safety regulations and expose themselves to unanticipated hazards.Hence, accepting risk management systems requires more than risk perception.

Despite the study results indicate a modest influence of safety climate on workers' risk perception and risk tolerance, the findings demonstrate that safety climate does affect workers' acceptance of risk management through their perception of risk and tolerance for risk. Therefore, relevant authorities should not overlook the importance of safety climate. Failure to acknowledge the importance of safety environment can lead to a bad impression of workplace safety, dissatisfaction with supervisory personnel, undervaluing the contributions of co-workers, and reduced confidence in safety programmes and taking safety-related actions. Workers' perception of risk is negatively impacted, and their willingness to take risks at work increases as a result. A risk mitigation technique is proposed for implementation in such circumstances. In order to ensure the use and comprehension of good risk management, the company must cultivate a risk-oriented culture. This implies that staff members and management need to have a clear concept about risk management, and all members of the organisation need to be aware of the detrimental effects that risk has on people and organisation at all levels. Thus, managers and superiors in authority should give priority to behavioural safety in order to exhibit a safe working environment. It is imperative for them to exemplify the "safety mindset" to the workforce. Therefore, the workers are more inclined to embrace the safety and risk management plan and behave in a manner that prioritises safety. Management may facilitate workers' understanding and acceptance of risk management by providing planning, support, supervision, encouragement, communication, policies, and training, which contribute to the development of their knowledge and attitudes. Nevertheless, the effectiveness of any proposed remedies relies on the active participation and ongoing backing of workers. Furthermore, the organisation must evaluate its occupational health and safety programme regularly, revise the safety culture and climate, and communicate the most recent updates to management, workers, and stakeholders.

Conclusions

This study revealed that safety climate has a direct impact on how workers perceive and tolerate risks. It is also showed the significance of risk perception as a mediator between safety climate and risk tolerance. This research investigated the values, beliefs, and perceptions of frontline personnel of two refineries regarding risk management. The study framework neglected to disclose the impact of organisational culture and technical systems, such as equipment safety and business processes, on the acceptability of worker risk management. This study therefore excluded technical systems that have the potential to influence employee performance. In order to increase acceptance of risk management, it is imperative that future research employs a comprehensive study design to validate causal links between technology and psychology at work environment.

Acknowledgement

The authors would like to thanks all the organizations, management and participating employees of the studied refinery companies in Malaysia who have participated in this project. Thanks also to Prof. (Dr) Amran Ab. Majid and Universiti Kebangsaan Malaysia (UKM) for arranging and supporting us in this research.

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