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Investigating the Impact of Psychosocial Safety Climate on Safety Behavior of Phosphate Mine Workers: A Dual Mediation Analysis

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Abstract Sustainable organizational performance is heavily reliant on employee health and safety, particularly in high-risk sectors like the mining industry, where unsafe practices can lead to catastrophic accidents and significant long-term productivity losses. Although research on psychosocial safety climate (PSC) is expanding, its underlying mechanisms remain underexplored in underrepresented contexts such as Morocco's phosphate mining industry. This study aimed to investigate the relationship between PSC and miners' safety behavior, specifically examining the mediating roles of learning opportunities and role ambiguity. Using a cross-sectional design, we collected data from 524 employees across three mining companies operating within the OCP Group through a structured survey. The hypothesized relationships were tested using partial least squares structural equation modeling. The findings revealed a significant positive effect of PSC on safety behavior. Role ambiguity was negatively associated with both PSC and safety behavior, whereas learning opportunities were positively related to both PSC and safety behavior. Moreover, both learning opportunities and role ambiguity were identified as significant partial mediators in the PSC-safety behavior relationship. These results indicate that organizations can enhance safety outcomes and support sustainable safety performance by fostering a strong psychosocial safety climate characterized by clear role definitions, effective safety training, and supportive leadership.

Keywords: psychosocial safety climate, role ambiguity, Job Demand-Resources Theory, accident reduction, learning opportunities, mediating, PLS-SEM

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1. INTRODUCTION

The mining sector has recently garnered increased attention for its efforts to reduce occupational risks through precautionary measures, including the adoption of advanced technologies (Sima & Moroșanu, 2022). Despite these improvements, the industry continues to face criticism due to persistently hazardous working conditions and a high number of reported occupational incidents (Milošević et al., 2025; Chebotarev et al., 2024). A significant proportion of these accidents is attributed to unsafe behaviors and inadequate working conditions. For instance, Derdowski & Mathisen, (2023) reported that approximately 90% of mining incidents are caused by hazardous employee actions. Globally, the International Labour Organization (ILO) estimates that approximately 7600 fatal workplace accidents occur daily (ILO, 2019). These alarming statistics underscore the pressing need for an integrated approach that considers the interplay between human behavior and safety systems to improve occupational safety in mining operations.

Consequently, safety behavior (SB) has become a focal point in contemporary occupational health and safety research. It refers to employees' actions aimed at reducing the likelihood of fatalities and injuries and is commonly divided into two dimensions established by Griffin and Neal et al. (2000): safety compliance, which entails adherence to obligatory procedures, and safety participation, which involves voluntary engagement in initiatives that promote workplace safety (Vinodkumar & Bhasi, 2010; Awais-E-Yazdan et al., 2023). Both forms of behavior are critical for preventing accidents and mitigating safety hazards.

A joint report from the World Health Organization (WHO) and the International Labour Organization further underscores that poor psychosocial working conditions contribute significantly to the rise in occupational accidents worldwide (Mashi et al., 2020). Consequently, psychosocial safety climate (PSC) has been identified as a fundamental organizational resource for fostering a safer work environment. Although recent studies by Yu et al. (2022) have demonstrated a direct relationship between PSC and safety behavior, the mechanisms underlying this relationship remain insufficiently explored. One potential pathway involves role ambiguity, defined as a lack of clarity regarding job responsibilities resulting from an imprecise allocation of tasks and responsibilities. High role ambiguity can reduce compliance with safety standards and increase the likelihood of unsafe practices (Yu et al., 2022; Mohamed et al., 2025). Conversely, PSC may act as a protective buffer, mitigating job-related uncertainties (Martínez-Díaz et al., 2021). Another pathway involves learning opportunities, which enhance employees' skills and motivation to adopt safe practices (Liang et al., 2022). Organizations that promote PSC create psychologically safe environments in which workers can engage in learning activities without fear of blame or negative repercussions (Amoadu et al., 2025).

To explain these mechanisms, this study draws on the Job Demands-Resources (JD-R) model and Conservation of Resources (COR) theory. The JD-R model suggests that PSC may influence safety behavior through two pathways: by reducing job demands, such as role ambiguity, which creates strain and undermines compliance; and by enhancing job resources,

such as learning opportunities, which motivate proactive engagement and build safety participation (Casey et al., 2021). COR theory complements this view by highlighting how PSC enables employees to preserve and accumulate valuable resources, thereby reducing strain and promoting safe behavior (Kim et al., 2020; Considine et al., 2017). However, despite growing interest in the link between PSC and safety behavior, critical gaps remain in understanding the psychological and environmental mechanisms involved. While prior studies have established the direct association between PSC and safety behavior (Wang & Kee, 2025; Yu et al., 2022), the role of mediating factors such as role ambiguity and learning opportunities has not been sufficiently addressed. This study contributes to the literature by proposing a dual mediation model in which PSC influences safety behavior through both a motivational pathway (via learning opportunities) and a stress-buffering pathway (via role ambiguity). By employing a cross-sectional design and analyzing responses from Moroccan miners, this research expands the geographic scope of PSC studies, most of which have focused on Western contexts (Yuan et al., 2024; Demerouti et al., 2001). The findings offer novel insights into safety practices in Moroccan mines and provide evidence-based recommendations for management to develop targeted interventions that safeguard workers' psychological well-being while promoting adherence to safety protocols.

2. REVIEW OF THE LITERATURE AND HYPOTHESIS DEVELOPMENT

2.1 Theory Underpinning the Research

This study draws on two complementary theoretical frameworks: the JD-R model and COR theory. Together, these theories provide a robust foundation for explaining the mechanisms through which the PSC influences safety behavior, particularly through the mediating roles of role ambiguity and learning opportunities. The JD-R model, proposed by Demerouti et al. (2001), offers a comprehensive structure for analyzing how different aspects of the work environment impact employee performance and well-being. It states that job characteristics can be divided into two main categories: job demands, such as role ambiguity, which refers to aspects of a job that require sustained cognitive or emotional effort and are therefore associated with certain physiological and psychological costs; and job resources, such as learning opportunities, which refer to aspects of the job that help in achieving occupational goals, reduce job demands, and promote personal growth and development (Yuan et al., 2024). Additionally, the JD-R model posits that a favorable work environment, particularly one that promotes open communication, psychological safety, and management support, can simultaneously reduce job demands and enhance job resources, leading to improved individual and organizational outcomes (Demerouti et al., 2001).

Within this framework, PSC is conceptualized as a critical antecedent that shapes the work environment. It sets the tone for how job demands and resources are perceived and managed across the organization. A strong PSC is associated with reduced role ambiguity, as it promotes clearer communication, defined responsibilities, and consistency in expectations (Holmgreen et al., 2017). Simultaneously, PSC enhances learning opportunities by fostering feedback,

mentoring, and personal development; all of which are motivational resources that can improve safety behavior (Yu & Li, 2020; Amoako et al., 2024).

Although other job resources (e.g., supervisor support, autonomy) and demands (e.g., workload and role conflict) could be relevant, learning opportunities and role ambiguity were selected for three reasons. First, they map directly onto the dual JD-R pathways: learning opportunities represent the motivational pathway, while role ambiguity captures the strain pathway. Second, both constructs are proximal to task performance in mining, where unclear roles and insufficient training are common precursors to accidents. Third, unlike more distal resources, learning opportunities and role ambiguity are directly actionable by management through interventions such as training programs, feedback systems, and role clarification. Their inclusion, therefore, provides both theoretical and practical relevance.

To further deepen the theoretical grounding, this study also draws on COR theory. According to COR theory, individuals are inherently motivated to acquire, maintain, and protect valued resources. Psychological stress occurs when these resources are threatened, lost, or insufficiently replenished (Holmgreen et al., 2017; Dollard & Bakker, 2010). When organizational climates like a strong PSC provide adequate resources, employees are more likely to engage in resource-conserving and resource-building behaviors (Fattori et al., 2022; Tripney et al., 2024). In such settings, a workplace with high PSC helps safeguard employees' psychological resources by minimizing uncertainty and offering development opportunities, thereby motivating employees to participate in proactive and safe actions. According to the theory, role ambiguity as a role stressor can cause stress reactions by depleting individuals' resources and putting their resources at risk (Dera et al., 2025; Mansour & Tremblay, 2019). Workers lacking both internal and external resources are also more vulnerable to experiencing stress (Bronkhorst, 2015). However, a positive environment with a strong PSC may buffer these adverse effects of role stress. Thus, integrating JD-R and COR theories provides a dual pathway explanation: a cognitive strain-reduction pathway through the mitigation of role ambiguity, and a motivational pathway through the promotion of learning opportunities. This integrated framework justifies the proposed dual mediation model, in which PSC influences safety behavior via both reduced job demands and increased job resources.

2.2 The Relationship between Psychosocial Safety Climate and Safety Behavior

Psychosocial Safety Climate refers to an organization's overarching framework of policies, procedures, and practices (3P) designed to prioritize employees' psychological well-being and occupational safety (Dollard & Bakker, 2010). A well-developed PSC reflects a workplace culture characterized by management commitment to safety, effective communication, employee involvement, and a consistent priority placed on health and safety issues (Fattori et al., 2022). Empirical studies have consistently demonstrated that PSC significantly influences job characteristics, particularly job demands and resources, by aligning organizational values with managerial practices, thereby playing a central role in influencing employee attitudes (Tripney et al., 2024).

PSC has also been shown to directly mitigate psychosocial risks, such as job stress and burnout, by ensuring that managers allocate sufficient resources and implement supportive practices. This is especially pertinent in high-risk sectors, where employees often face intense physical and psychological demands. In such contexts, PSC not only reflects the organization's commitment to safety but also enables workers to perceive greater access to benefits, recognition, and developmental opportunities, factors that promote safer work behavior and organizational loyalty (Yu et al., 2022). For instance, a study conducted in the Libyan construction sector found that high levels of PSC, combined with supportive safety leadership, were associated with greater employee engagement in safety practices (Dera et al., 2025). Similarly, research on Canadian nurses in Quebec revealed that higher PSC was linked to reduced burnout and lower reliance on risky safety workarounds (Mansour & Tremblay, 2019). These findings are corroborated by other empirical evidence showing a positive association between PSC and individual safety behavior, including proactive engagement and compliance with safety standards (Bronkhorst, 2015). Notably, a study by Zadow et al. (2017) found that PSC was among the most significant predictors of reduced work-related injuries.

In parallel, safety behavior encompasses workplace practices intended to prevent accidents and ensure safe operations (Probst & Brubaker, 2001). An increase in safety behavior reflects higher safety awareness, which leads to fewer workplace accidents and promotes sustainable hazard prevention within organizations (Lu et al., 2020). Griffin and Neal (2000 categorized safety behavior into two components: safety compliance, which involves adherence to required safety protocols (e.g., proper use of protective equipment), and safety participation, which includes voluntary efforts to enhance workplace safety, such as assisting colleagues and engaging in safety initiatives.

2.3 The Intermediary Function of Role Ambiguity in Psychosocial Safety Climate and Safety Behavior

Role ambiguity (RA) has emerged as a significant psychosocial determinant of employee health, attracting substantial scholarly attention (Langove et al., 2024; Yokouchi, 2024). It is defined as the extent to which employees experience uncertainty regarding job performance expectations, the methods required for task execution, and the outcomes associated with their performance (Zhu et al., 2020). Theoretically, RA is recognized as a major workplace stressor that can lead to cognitive overload, requiring continuous effort to interpret unclear job demands (Saraih et al., 2023). This strain adversely affects psychological well-being and impairs employee job performance.

Role ambiguity is believed to disrupt motivational processes by increasing the perceived level of job demands (Martínez-Díaz et al., 2020). This uncertainty erodes motivation and intensifies psychological strain (Karasek, 1979). A substantial body of literature has documented its adverse effects, linking it to increased depression (Zhang et al., 2022), psychological distress (Wu et al., 2018), job insecurity (Inoue et al.,2018), job burnout (Wu et al., 2019), reduced organizational citizenship behavior (Eatough et al., 2011), diminished job satisfaction (Donley, 2021), impaired mental health (Zhang et al., 2024), and lower job

performance (Lee et al., 2024). As a critical source of role stress, role ambiguity contributes to emotional exhaustion, mental fatigue, decreased motivation, and an overall decline in work performance (Alblihed &Alzghaibi, 2022). Furthermore, anxiety is frequently associated with role ambiguity and has been found to strengthen the relationship between psychological distress and job-related stressors (Zhang et al., 2024). Empirical research also indicates that ambiguous roles reduce employees' willingness to adhere to organizational norms and guidelines, thereby negatively affecting their safety practices (Huang et al., 2021; Ghasemi et al., 2018). For instance, a study by Wu and Li et al. (2022) found that employees with unclear role definitions are significantly less likely to comply with safety standards and procedures, often resorting to shortcuts that compromise workplace safety.

Beyond safety outcomes, role ambiguity is increasingly recognized as a barrier to innovative work behavior. As a source of uncertainty, it hinders employees from fully utilizing their capabilities and generating creative solutions. Conversely, a supportive PSC is known to boost employee satisfaction and decrease emotional exhaustion, thereby creating a psychologically safe environment conducive to innovation. Empirical studies suggest that psychological safety plays a critical role in fostering innovative intentions, especially when role ambiguity is minimized, enabling employees to take risks and initiate improvement (Hadini & Etikariena, 2024).

While existing research has primarily examined the mediating role of role ambiguity in the context of job satisfaction and organizational commitment (Homayed, 2020), limited attention has been given to its function within the relationship between PSC and safety behavior. Employees operating in supportive environments with well-defined roles are more likely to engage in proactive safety behaviors (Charteris et al., 2024; Nangle et al., 2010). In contrast, a high level of role ambiguity may impair safety compliance, as unclear responsibilities lead to confusion and reduced adherence to safety protocols, ultimately increasing the risk of workplace incidents (Duan et al., 2024; Law et al., 2011). This study posits that role ambiguity serves as a mediator between PSC and safety behavior. In light of this relationship, we put forward the following hypothesis:

H1: Role ambiguity has a negative impact on safety behavior.

H2: Psychosocial safety climate has a negative impact on role ambiguity.

H3: Role ambiguity mediates the relationship between psychosocial safety climate and workers' safety behavior.

2.4 The Intermediary Function of Learning Opportunities in Psychosocial Safety Climate and Safety Behavior

Learning opportunities are recognized as a critical job resource encompassing physical, psychological, and social dimensions that support employees in achieving work-related objectives (Charteris et al., 2024). It is therefore anticipated that a strong PSC exerts a significant influence on the availability of learning opportunities, even when other

organizational climate factors are present. In high-risk industries such as mining, safety behavior is heavily dependent on the workforce's knowledge and skillset. According to Bandura et al. (2010), individuals acquire behaviors by observing and imitating others, underscoring the importance of external influences in shaping behavioral outcomes. In the workplace, employees who are exposed to safety-related learning experiences, such as observing safety practices or participating in training programs, are more likely to adopt and consistently demonstrate safe behaviors. Training programs represent a primary avenue for providing learning opportunities in organizational settings. Extensive research has demonstrated that well-designed safety training enhances employees' knowledge, attitudes, and behaviors concerning safety. For instance, a study by Duan et al. (2024) revealed that safety training programs emphasizing interactive and participatory methods are more effective in promoting safety behavior than passive, lecture-based approaches. By encouraging hands-on practice and problem-solving during training, employees become better equipped to address safety-related challenges in real-world scenarios. Supporting this, Neal and Griffin (2006) reported that employees who perceive themselves as more competent in safety, an outcome strengthened through access to learning opportunities, are more likely to engage in proactive safety behaviors such as hazard identification and incident reporting.

From a broader organizational perspective, decision-makers and supervisors who prioritize employee well-being, a characteristic of organizations with high PSC, tend to focus on reducing job stressors and enhancing job resources to safeguard employee welfare (Kohnen et al., 2024). Given that PSC is inherently focused on promoting psychological well-being, organizations that value mental health are more inclined to invest in learning opportunities. This proactive approach stems from managerial recognition that insufficient resources intensify job demands, increasing employee stress levels and undermining performance (Hall et al., 2010).

Within the framework of the present investigation, it is hypothesized that learning opportunities mediate the relationship between PSC and worker safety behavior. Although previous research has not explicitly examined this mediation pathway, existing literature suggests that learning opportunities function as mediators between organizational climate and worker behaviors (Wilson et al., 2004; Butts et al., 2006). Furthermore, they have been identified as a significant factor influencing employee commitment and engagement within the organization (Brislin, 1970). Based on the aforementioned arguments, the following hypotheses are proposed:

H4: Learning opportunities have a positive impact on safety behavior

H5: Psychosocial safety climate is positively associated with learning opportunities.

H6: Learning opportunities mediate the relationship between psychosocial safety climate and safety behavior.

The conceptual framework proposed for this study is shown in Figure 1.

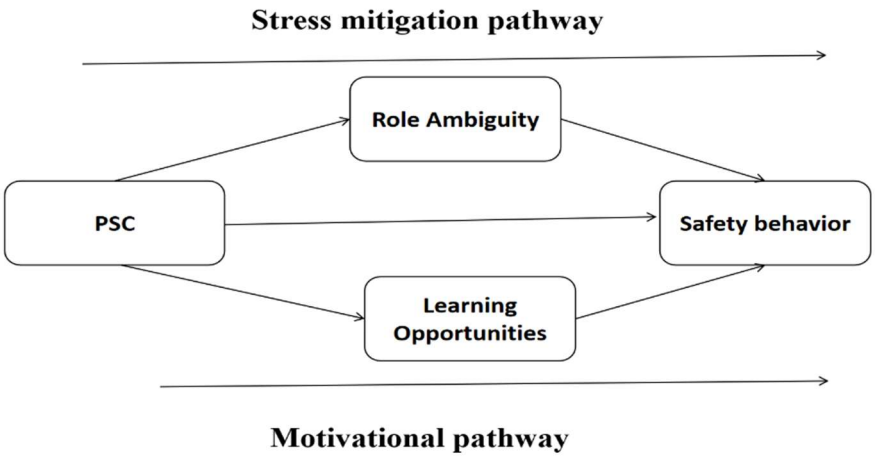

Figure 1. Research framework

3. RESEARCH METHOD

3.1 Participants and Procedure

Data for the present study were collected using a structured questionnaire comprising 30 items divided into two main sections. The first section gathered demographic information, including gender, age, education level, and work experience, to characterize the sample. The second section measured the key research variables, including PSC, safety-related behaviors, role ambiguity, and their views on learning opportunities for workplace safety, using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), enabling the individuals to describe varying levels of agreement.

Participants were recruited using a convenience sampling method from three phosphate mining sites located in Benguerir, Youssoufia, and Khouribga, selected for being among the largest and most representative phosphate operations in Morocco under the OCP group. The study primarily targeted employees working in non-supervisory roles. Prior to participation, individuals were informed in writing that their involvement was entirely voluntary and they could withdraw from the study at any point without providing a reason. To maximize participation, the survey was administered in both hard copy and online (via Google Forms). Four trained assistants facilitated the data collection process by distributing questionnaires, guiding participants, and ensuring accurate completion.

Ethical approval for the study was obtained from the ethical committee at Anhui University of Science and Technology. Written consent and confidentiality agreements were secured from the participant mining companies before data collection commenced. The data collection occurred in two phases over four months (March to July 2024). The first phase focused on demographical details, safety behavior, and PSC, while the second phase assessed the

mediating variables (role ambiguity and learning opportunities). A pilot test with 20 questionnaires was conducted to ensure the clarity and comprehensibility of the items.

Of the 632 questionnaires distributed, 560 responses were returned. After excluding 36 responses due to inconsistencies or incompleteness, a total of 524 valid responses were retained for analysis.

As shown in Table 1, a large proportion of respondents identified as male (85.2%), with the largest age group being 35-44 (26.7%). Most respondents had technical diplomas, while nearly 30% held a bachelor's degree or higher. Additionally, 48.6% of participants reported having mid-level work experience within their company. Table 1 provides a complete description of the sample characteristics.

Table 1. The population statistics of the research participants

		Frequency	Percentage
Gender	Male	442	85.2%
	Female	78	14.8%
Age	18-24	116	22.1%
	25-34	137	26.1%
	35-44	140	26.7%
	45-54	84	16.2%
	55-64	47	8.9%
Education	Secondary school or below	167	19.%
	Technical training institution	255	48.6%
	Undergraduate or above	102	31.8%
Work experience	Entry-level experience	129	24.6%
	Mid-level experience	255	48.6%
	Senior-level experience	140	26.8%

3.2 Measurement Variable

The items used in this study were adapted from previously validated research instruments to suit the context of the Moroccan phosphate mining industry. All items were translated into Arabic. To ensure linguistic and cultural appropriateness, a forward-backward translation procedure was applied, involving two bilingual experts, following established guidelines (Brislin, 1970). Discrepancies between the original and back-translated versions were thoroughly discussed and resolved to maintain semantic equivalence. Furthermore, minor wording adjustments were made to improve clarity, particularly for participants with a lower level of education. For instance, terminology such as “psychological well-being” was simplified to “mental health”. No items were added or removed; only minor phrasing modifications were introduced to enhance readability without altering the original conceptual meaning. The following provides a comprehensive description of the measurements used for each variable:

Psychosocial safety climate: PSC was assessed using items adapted from the twelve-item PSC-12 scale developed by Hall et al. (2010). In this study, six items were retained to represent the four dimensions of PSC: management commitment, organizational communication, organizational participation, and management priorities. The items were slightly reworded to reflect the mining context (using "supervisor" rather than "senior management") as this wording is commonly understood by mine workers. Importantly, the adaptation was limited to wording adjustments to improve comprehension and appropriateness of the PSC scale for the Moroccan mining setting. Responses were recorded on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Sample items include: "In my workplace, managers act quickly to address problems affecting employees' mental health", "Concerning issues affecting my mental health, I can get timely communication", "Managers believe that employees' mental health and productivity are equally important". The scale demonstrated strong internal consistency with a Cronbach's alpha of 0.870.

Safety behavior: Safety behavior was measured using a six-item scale developed by Neal (2006) that combines two elements (safety compliance and participation). Responses were recorded from 1 (strongly disagree) to 5 (strongly agree). Illustrative items include: "I put in extra effort to improve the safety of the workplace", and "I voluntarily carry out tasks or activities that help to improve workplace safety". The scale demonstrated strong internal consistency, with a Cronbach's alpha of 0.830.

Role ambiguity: To measure role ambiguity, a five-item scale was developed by Rizzo et al. (1970). Following the approach of previous studies, the items were reverse-coded so that higher scores reflected a greater level of role ambiguity. An example item is, "I feel certain about how much authority I have". The scale demonstrated an acceptable level of internal consistency with a Cronbach's alpha of 0.977.

Learning opportunities: For the measurement of learning opportunities, a five-item scale was chosen (Bakker et al., 2003). The study items were recoded from 1 (strongly disagree) to 5 (strongly agree) to responses on the questionnaires provided to participants, such as "I have sufficient possibilities to develop myself at work", "I have an opportunity to develop my special abilities". The items used align with those in the Job Content Questionnaire that measures skill discretion, which is a type of job control. The scale demonstrated a strong level of internal consistency with a Cronbach's alpha of 0.890.

3.3 Reliability and Validity of Measures

To assess the reliability and validity of the constructs used in the study, we evaluated the measurement model using SmartPLS4, following established procedures for Partial Least Squares Structural Equation Modelling (PLS-SEM). Specifically, the evaluation included tests for indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. All retained items demonstrated outer loadings above the recommended threshold of 0.70, indicating satisfactory indicator reliability. Composite reliability (CR) values ranged from 0.777 to 0.896 across constructs, exceeding the acceptable benchmark of 0.70, thereby

confirming internal consistency. In addition, all Average Variance Extracted (AVE) values surpassed the 0.50 cutoff, providing evidence of convergent validity. Discriminant validity was verified using the Fornell-Larcker criterion, which demonstrated that the square root of the AVE for each construct exceeded its highest correlation with any other construct. This confirms that each latent construct is empirically distinct.

As the study is theory-driven and tests clearly specified hypotheses grounded in prior literature, the focus was on a confirmatory assessment of the measurement model. Therefore, the factor analysis conducted serves to validate the predefined structure rather than to explore latent dimensions inductively. A detailed summary of the measurement model assessment is presented in Tables 2,3, and 4. For instance, the square root of the value of the AVE for PSC was 0.820, which is greater than its correlations with SB (0.792), LO (0.720), and RA (0.502). The square root of AVE for SB (0.800) exceeds its correlation with PSC (0.792), LO (0.767), and RA (0.634). The square root of the AVE for LO (0.786) was greater than PSC (0.720), SB (0.767), and RA (0.714). For RA, the square root of its AVE (0.765) exceeded its correlations with PSC (0.502), SB (0.634), and LO (0.714). These results confirm that each construct is distinct from the others, demonstrating clear discriminant validity across all pairs of variables.

Table 1. Confirmatory factor analysis of the study

Model index fit	Recommended Value	Estimated model
χ2/df	1-3 [62]	1.715
TLI	≥0.95 [60, 63]	0.945
GFI	≥0.9 [63, 64]	0.944
SRMR	<0.08 [60]	0.036
CFI	≥0.95 [60, 63]	0.952
RMSEA	<0.06 [60, 63]	0.038

Table 3. Contract reliability and validity of the study

	rho_a	rho_c	AVE
PSC	0.862	0.856	0.676
SB	0.909	0.896	0.640
LO	0.755	0.777	0.618
RA	0.856	0.850	0.585

Table 2. Discriminant validity – Fornell-Larcker criteria

	PSC	SB	LO	RA
PSC	0.820			
SB	0.492	0.800		
LO	0.720	0.767	0.786	
RA	0.502	0.634	0.714	0.765

3.4 Test of Common Method Variance/Bias

Dataset bias may occur when both independent and dependent variables are collected through the same survey using an identical response format. This common method bias can

potentially compromise the validity and reliability of research outcomes (Podsakoff et al., 2003). To address this issue, Harman's single-factor test was conducted in the present study (Podsakoff & Organ, 1986). The analysis revealed that the first unrotated factor accounted for only 26.39% of the total variance, which is well below the commonly accepted 50% threshold. These results suggest that common method bias is unlikely to be a serious concern, and the relationships among variables are likely to be genuine rather than an artifact of the measurement method.

4. DATA ANALYSIS

The data analysis was conducted using the advanced software SmartPLS4. Prior to analysis, data cleaning and filtering procedures were undertaken to address issues such as incomplete responses and to assess the normality. Subsequently, an evaluation of outer loadings was performed, leading to the removal of 7 items that exhibited factor loadings below the recommended threshold of 0.7.

Confirmatory factor analysis was then employed using SmartPLS4 to examine the model's goodness of fit. The model validation process involved assessing the measurement model and comparing fit indices against established benchmarks (Hu & Bentler, 1999). Among various model specifications tested, the one demonstrating the best alignment with these criteria was selected for subsequent analysis. To ensure convergent validity, the constructs' reliability and Average Variance Extracted were analyzed. The Partial Least Squares Structural Equation Modeling (PLS-SEM) was used to test the proposed hypotheses. PLS-SEM is particularly well-suited for estimating complex relationships among latent constructs and is recognized for its robustness with smaller sample sizes, as well as its predictive capabilities and practical flexibility (Duong & Ho, 2024).

5. RESULTS

Descriptive statistics for the study variables are presented in Table 5. Mean values ranged from 3.001 to 4.183, indicating that participants generally responded toward the higher end of the five-point Likert scale. Standard deviation (SD) varied from 0.417 to 0.754, reflecting a reasonable degree of response variability. Excess Kurtosis values ranged from 0.151 to 3.001, suggesting a clustering of responses at the distribution's tails for certain items. Skewness values ranged from -1.326 to -0.111, indicating a left-skewed distribution for the responses.

As outlined in Table 6, a mediation analysis was conducted to examine the mediating roles of role ambiguity (RA) and learning opportunities (LO) in the relationship between PSC and safety behavior (SB), employing the bootstrapping method with 5,000 resamples. This analysis captured both indirect and direct effects. The direct effects illustrate the immediate associations

between the variables, while the indirect effects provide insights into how PSC influences SB through the mediating roles of RA and LO, based on the responses gathered.

The results revealed a positive and significant impact of PSC on SB (H1: C = 0.969, t = 8.792, p < 0.001). Additionally, PSC was negatively and significantly associated with RA (H2: C = -0.967, t = 14.08, p < 0.001). The impact of RA on SB was also negative and statistically significant (H3: C = -0.273, t = 10.20, p < 0.001). Regarding learning opportunities, PSC exhibited a significant positive effect on LO (H4: C = 0.649, t = 3.551, p < 0.001), and LO, in turn, significantly predicted SB (H5: C = 0.506, t = 5.551, p = 0.020). In terms of mediation, PSC significantly influenced SB through RA (indirect effect: C = 0.860, t = 5.782, p < 0.001) and through LO (indirect effect: C = 0.054, t = 2.548, p = 0.010). These findings support all the proposed hypotheses, indicating that both RA and LO serve as significant partial mediators in the relationship between PSC and SB (as shown in Figure 2).

Table 5. Descriptive statistics

Name	Mean	Standard deviation	Excess kurtosis	Skewness
PSC1	3.718	0.511	2.646	-1.114
PSC2	4.011	0.611	0.243	-0.283
PSC3	3.147	0.515	2.961	-0.916
PSC4	3.544	0.754	2.537	-0.237
PSC5	3.047	0.424	2.215	-0.170
PSC6	4.183	0.481	2.233	-0.916
RA1	3.001	0.599	0.514	-0.114
RA2	3.917	0.265	0.151	-0.228
RA3	3.558	0.528	0.914	-0.586
RA4	3.566	0.517	0.254	-0.209
RA5	3.075	0.753	1.171	-0.107
LO1	3.765	0.750	2.147	-0.889
LO2	3.044	0.622	0.271	-0.701
LO3	3.184	0.464	0.440	-0.111
SB1	3.688	0.417	3.001	-1.326
SB2	3.896	0.559	0.477	-0.659
SB4	3.158	0.615	1.092	-0.556
SB5	3.772	0.609	2.400	-0.609
SB6	3.422	0.571	2.996	-1.022

Table 6. Mediation analysis results

	Coefficient	T value	P value
Direct effect			
PSC->SB	0.435	7.972	0.000
PSC->RA	-0.585	13.284	0.000
PSC->LO	0.497	10.264	0.000
RA->SB	-0.180	3.366	0.001
LO->SB	0.288	5.551	0.021
Indirect effect			
PSC->RA->SB	0.105	3.250	0.001
PSC->LO->SB	0.143	5.187	0.000
Total effect			
PSC->SB	0.683	10.748	0.000

P < 0.01, the interaction reaches significance with regard to the 0.01 level.

Furthermore, the total effect of PSC on SB was significant (C = 0.683, t = 10.748, p < 0.001). It is important to note that the path coefficients from PSC to the mediators (RA, LO) and from the mediators to SB are equivalent to their direct effects. This is because these specific pathways are not mediated by other variables in the model; their total effects have no direct components.

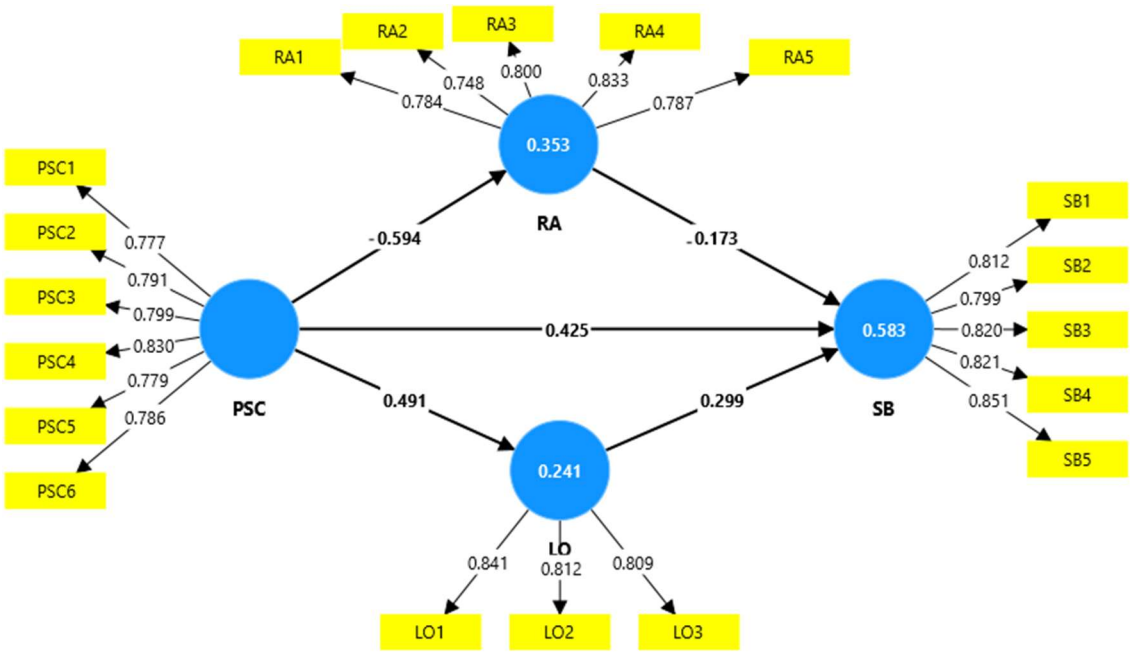

Figure 2. PLS-SEM model

6. DISCUSSION

This study aimed to extend and validate the influence of PSC on safety behavior within the Moroccan mining industry. Specifically, the research investigated the direct effect of PSC on safety behavior and assessed the mediating roles of how two key factors, learning opportunities and role ambiguity, mediate this relationship. Understanding these mechanisms is critical for guiding management in developing strategic interventions to enhance safety behavior and reduce accident rates in high-risk environments. The findings support several hypothesized links in the proposed conceptual framework, enriching theoretical understanding of workplace safety behavior, particularly within the context of the JD-R and COR theories.

The results revealed that PSC positively and significantly influences safety behavior, consistent with prior research identifying PSC as a key determinant of employee behavior (Yu et al., 2022). Similarly, PSC directly affects behaviors among staff members (Siami et al., 2023; Caniëls & Baaten, 2019). The analysis demonstrates that learning opportunities partially mediate the relationship between PSC and safety behavior. These findings are consistent with existing literature (Amoadu et al., 2025), which highlights the significance of learning opportunities in supporting safety performance. The partial mediation suggests that PSC contributes not only by increasing access to training but also by fostering a supportive and

engaging work environment that enhances trust and perceived organizational support, both of which directly influence safety behavior. This is in line with the findings of (Granger et al., 2024). It also conforms to the Job Demands-Resources (JD-R) theory, which posits that job resources such as learning opportunities enhance employee motivation and enable proactive safety engagement (Zhao & Li, 2024; Martínez-Díaz et al., 2021).

Furthermore, the results indicate that PSC significantly reduces role ambiguity. This indicates that in the context of the organization, a supportive PSC is effective in decreasing uncertainty in job roles. This view is supported by Hobfoll (2010), who argues that the presence of the leader's support is crucial in fending off the adverse effects of job demands. Similar to the findings of this study, Li et al. (2022) suggest that resources such as role clarity are important for reducing stress and enhancing performance. Additionally, a statistically significant negative association was found between role ambiguity and safety behaviors. This implies that employees experiencing uncertainty in their job responsibilities may be more likely to commit errors, overlook safety protocols, or feel less confident in their safety-related decision-making. The finding is consistent with a substantial body of research positing that job demands like role ambiguity can lead to stress and decrease engagement in safety practices (Hobfoll, 2011). Finally, the results confirm the indirect impact of psychological safety climate on safety behavior via role ambiguity, indicating that PSC not only enhances role clarity but also provides resources that help mitigate the negative impact of role ambiguity on safety behavior.

Particularly in the context of the JD-R and COR theories (Endres & Chowdhury, 2022; Holmgreen et al., 2017), this study provides a number of significant theoretical implications that further the understanding of occupational health and safety and organizational behavior. First, the study verifies and expands the JD-R model dual pathways structure by showing that PSC operates via both role ambiguity (as a job demand) and learning opportunities (as a job resource). This integration emphasizes both motivational and health impairment pathways, providing a more holistic understanding of the mechanisms underpinning employee safety behavior. Second, it contributes to COR theory by showing how PSC enables the accumulation and preservation of valuable psychological resources such as job clarity and skill development. This aligns with Endres and Chowdhury (2022), who indicates that learning strategies are associated with task complexity in the working environment. These resources support COR's claim that resources gain strengthen employee motivation and resilience by lowering the risk of mental strain and encouraging proactive safety participation. Finally, by placing the research investigation in the neglected context of Moroccan mining, this study fills a geographical and industry gap in the safety literature. It highlights the cross-cultural applicability of the COR and JD-R models, thus strengthening potential external validity.

From a practical perspective, the study offers several recommendations for managers and safety professionals in the Moroccan mining sector. First, organizations should prioritize strengthening PSC by embedding supportive policies, procedures, and practices (3P) that safeguard workers' mental health. This requires more than a formal policy; managers must actively demonstrate commitment through transparent communication, visible leadership

engagement, and meaningful worker participation in safety decision-making. Such action builds trust and signals that psychological well-being is valued as highly as productivity.

Second, organizations should take proactive steps to reduce role ambiguity by clarifying responsibilities, expectations, and reporting lines. This can be achieved through structural communication strategies such as regular team briefings, role-specific manuals, and digital reporting systems that provide timely feedback. Reducing ambiguity not only helps employees comply with safety procedures but also decreases stress and hesitation in high-risk situations, which are common in mining operations.

Third, managers should establish a continuous learning system that includes mentoring programs, peer-to-peer knowledge sharing, and targeted training relevant to mining tasks. Importantly, training should be directly linked to mining tasks and emerging risks, ensuring that employees see its relevance and can immediately apply what they learn. Managers should also encourage upward feedback and open dialogue, creating a psychologically safe space for employees to raise concerns and share innovative safety ideas without fear of blame.

By simultaneously reducing job demand and enhancing job resources, mining organizations can foster a dual pathway to sustainable safety performance. In resource-intensive and high-risk contexts like the Moroccan mining sector, this integrated approach is not only beneficial but essential for cultivating a resilient safety culture, reducing accident rates, and sustaining long-term operational effectiveness.

6.1 Limitations of the Study

Like many research studies, this particular study has certain limitations. The data collection technique employs a cross-sectional approach, which only captures an overview of the current conditions at a specific point in time, without considering potential long-term changes or developments. To address this, future studies could benefit from using a longitudinal approach, which would require long-term data collection. Second, the study mainly uses measurement scales that were designed and validated in a different setting. While these scales are useful, they might not fully represent the complexities and specifics of the local environment. Therefore, future research could aim to develop and test measurement scales that are more tailored to the local context, ensuring the findings are both culturally and contextually appropriate.

Furthermore, the research's focus on a specific population may limit how widely the results can be applied. To enhance the validity and reliability of the findings, future research should include comparative studies of different populations. Additionally, future studies should explore other potential mediators that might affect the relationship between PSC and safety behavior, such as organizational culture, transformational leadership, and personality traits. These factors could have a significant influence on safety behavior and deserve thorough investigation.

7. CONCLUSION

In summary, this study contributes to a deeper understanding of how psychosocial safety climate influences safety behavior among workers in high-risk environments, using the Moroccan mining sector as a representative empirical context. By identifying learning opportunities and role ambiguity as dual mediators, the research demonstrated that psychosocial safety climate not only serves as a protective buffer against harmful job demands but also serves as a motivational resource that encourages employees' proactive engagement with safety practices.

List of Abbreviations

PSC	Psychosocial safety climate
LO	Learning opportunities
RO	Role ambiguity
SB	Safety behavior
JD-R	Job demands-resources
COR	Conservation of resources

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COMPETING INTERESTS

The authors declare no competing interests.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the National Social Science and Excellent Scientific Research and Innovation Team Support Project of Universities and Colleges in Anhui Province. Informed consent was obtained from all subjects involved in the study. All methods were carried out according to relevant guidelines and regulations.

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APPENDIX

	Items	Strongly disagree	Disagree	Neutral	agree	Strongly agree
PSC1	In my workplace, managers act quickly to address problems affecting employees' mental health.					
PSC2	Concerning issues affecting my mental health, I can get timely communication.					
PSC3	Managers believe that employees' mental health and productivity are equally important.					
PSC4	I feel encouraged to speak up about mental health and safety issues.					
PSC5	Supervisor actively listens when employees express work-related stress.					
PSC6	My input on psychosocial health and safety is taken seriously.					
RA1	I feel certain about how much authority I have. (Reversed)					
RA2	Clear, planned goals and objectives will exist for my job. (Reversed)					
RA3	I know everything that I am expected to do at work with certainty. (Reversed)					
RA4	Explanation will be clear about what has to be done. (Reversed)					
RA5	My job duties are clearly defined. (Reversed)					
SB1	I put in extra effort to improve the safety of the workplace.					
SB2	I voluntarily carry out tasks or activities that help to improve workplace safety.					
SB3	I use all the necessary safety equipment to do my job.					

SB4	I use the correct safety procedures for carrying out my job.					
SB5	I promote the safety program within the organization.					
LO1	I receive feedback, mentoring, or coaching at work.					
LO2	I have sufficient possibilities to develop myself at work.					
LO3	I have an opportunity to develop my special abilities.					