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Psychosocial Safety Climate as a Mediator Between Safety Culture and Perceived Safety Performance in East Java Mid-Rise Construction Projects

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ABSTRACT

Construction safety in developing economies remains shaped by the interaction between formal safety systems and daily site conditions. This cross-sectional survey examined whether psychosocial safety climate (PSC) mediates the association between safety culture and perceived safety performance among 132 male workers from six selected mid-rise construction projects in Malang, Jember, Kediri, and Surabaya, East Java, Indonesia. The study used translated and adapted questionnaire items and analyzed the data with PLS-SEM. Safety culture was positively associated with PSC (beta = 0.801, $p < 0.001$) and perceived safety performance (beta = 0.347, $p = 0.025$). PSC was also positively associated with perceived safety performance (beta = 0.476, $p = 0.001$). The indirect path from safety culture to perceived safety performance through PSC was significant (beta = 0.381, $p = 0.001$), with a total effect of 0.728 and VAF of 52.3%. These findings suggest partial mediation rather than causal improvement. The study contributes to construction safety engineering by showing how PSC can be embedded into toolbox meetings, work-at-height supervision, PPE inspections, fatigue checks, and confidential psychosocial hazard reporting.

1. INTRODUCTION

Construction remains one of the most hazardous industries because workers perform dynamic activities in changing spaces, exposed weather, temporary access routes, lifting operations, and work at height. Official fatality statistics still identify falls, slips, and trips as major sources of construction deaths, while industry safety reports continue to show that nonfatal injuries often arise from temporary work platforms, poor hazard recognition, material handling, and unsafe access conditions [1, 2]. Indonesia faces the same challenge within a fast-expanding infrastructure environment, where national work accident records show a continuing burden of occupational incidents and East Java accounts for a large share of reported cases [3]. These figures are important for construction safety engineering because they point to risks that cannot be controlled only through written procedures. They require stable occupational safety and health (OSH) systems, reliable site supervision, personal protective equipment (PPE) discipline, near-miss reporting, and worker participation in daily risk control [4].

Mid-rise projects in East Java provide a relevant empirical setting for this problem. Workers in such projects move from ground-level activities to formwork, reinforcement, masonry, concrete work, scaffolding access, and finishing tasks at elevated levels. These activities increase exposure to fall hazards and require consistent use of helmets, harnesses, shoes, guardrails, work permits, and toolbox briefings. At the same time, construction crews are often temporary, subcontracted, and organized around short production schedules. Under these conditions, safety rules may be formally available but unevenly understood, reported, and enforced at the workface [5, 6].

The same construction setting also produces psychosocial pressure. Workers may hesitate to challenge unsafe instructions when they depend on daily wages, project continuity, or supervisor approval. Low formal education can reduce confidence in interpreting written procedures, filling incident forms, or discussing near misses during briefings. Time pressure may also encourage shortcuts, especially when concrete pouring, lifting, or elevated work must be completed within tight schedules. These conditions connect construction engineering controls with psychosocial climate because worker fatigue, fear of blame, low voice, and supervisor pressure can influence whether site rules become real safety behavior [7, 8].

Safety culture is widely used to explain why formal safety systems succeed or fail. It refers to shared values, assumptions, practices, and managerial priorities that define how safety is treated in an organization [5, 9-11]. In construction, a strong safety culture should support training, hazard control, PPE enforcement, accident reporting, and safe supervision. However, safety culture can become an abstract construct if it is not linked to the mechanisms through which workers decide to speak, report, comply, and participate. This issue is central to the present study because the reviewer concern is not whether safety culture matters, but how safety culture becomes visible in construction site practices.

Psychosocial safety climate (PSC) helps explain that mechanism. PSC captures workers' shared perception that management protects psychological health, prioritizes psychosocial risk prevention, communicates openly, and involves workers in risk-related decisions [12]. Unlike a general safety climate, PSC focuses on the psychosocial conditions that affect voice, fatigue, stress, pressure, and willingness to report unsafe conditions [13]. In construction, this does not replace engineering controls. It adds a climate layer that can support toolbox meetings, work-at-height permits, PPE inspection, and near-miss reporting when workers face physical risks and psychosocial demands at the same time [14-16].

1.1 Empirical issues in East Java mid-rise construction safety

The empirical issue in the sampled projects is not limited to the existence of construction hazards. The stronger problem is how formal OSH arrangements are interpreted by workers with different ages, education levels, trades, and project durations. The sample includes general labourers, formwork and carpentry workers, reinforcement workers, and masonry or concrete workers, all of whom face different task risks. Many workers reported short work duration on the project, which can limit their familiarity with project-specific safety routines. Table 1 translates these site realities into the model logic used in this study.

The table shows why PSC is treated as more than an organizational psychology construct in this article. Work at height, PPE compliance, toolbox meetings, reporting, supervision, and OSH systems operate through human decisions under site pressure. A worker may understand a rule but still remain silent when a supervisor pushes production, when a crew member feels fatigued, or when a near miss is seen as too minor to report. In this sense, PSC is placed inside construction safety management rather than outside it. The study therefore examines perceived safety performance as the outcome because the available data measure worker perceptions rather than accident rates, inspection scores, or observed unsafe acts.

1.2 Analytical gap and study objectives

Prior research has examined safety culture, safety climate, and safety behaviour in construction, but the boundary between these concepts is often blurred [14, 17, 18]. Safety culture tends to capture deep organizational values and practices, while safety climate captures workers' perceptions of how safety is prioritized in daily operations [9, 19]. PSC differs because it focuses on psychological health and psychosocial risk prevention, including the management of fatigue, stress, communication, involvement, and voice [20]. Recent construction studies show growing interest in PSC, but fewer studies test whether PSC mediates the link between safety culture and perceived safety performance within developing-economy construction projects [14-16, 21].

Table 2 summarizes the research problem matrix used to connect each reviewer concern with the corresponding revision in the manuscript.

Table 1. Empirical safety issues and model relevance in the sampled projects

Site Condition	Construction Safety Concern	Model Relevance
Work above the fourth floor	Higher exposure to falls, scaffolding hazards, vertical material movement, and weather-related distraction	Justifies linking organizational safety culture with work-at-height supervision and perceived safety performance
PPE and fall-prevention control	Helmets, shoes, harnesses, guardrails, and access control require daily supervision and worker compliance	Connects formal safety culture with visible site practice rather than abstract policy
Short-term and project-based employment	Workers may avoid reporting fatigue, pressure, or unsafe instructions because employment continuity is uncertain	Explains why PSC may influence reporting, participation, and perceived safety system credibility
Low formal education among workers	Written OSH procedures and incident forms may not be equally understood by all workers	Supports the need for toolbox communication, demonstration, and supervisor translation of safety expectations
Near-miss and accident reporting	Manual reporting can be weak when workers fear blame or believe reports will not change site conditions	Shows why psychosocial climate may support reporting and learning before accidents occur

Note: occupational safety and health (OSH); psychosocial safety climate (PSC); personal protective equipment (PPE)

Table 2. Research problem matrix

Problem Area	Evidence in the Study Context	Revision Response in the Manuscript
Overstated causal framing	The design is cross-sectional and all variables are self-reported	The title, abstract, hypotheses, discussion, and conclusion use association, mediation, and perceived safety performance
Weak link with construction engineering	Reviewers requested work at height, PPE, accident reporting, training, supervision, and OSH systems	The introduction, discussion, and practical implications now link PSC with site safety practices
Construct overlap	Safety culture, safety climate, PSC, and safety performance can appear conceptually close	The literature review provides conceptual boundaries and a table separating each construct
Soft safety performance evidence	No objective accident records, near-miss logs, or inspection scores were available	The outcome is renamed perceived safety performance and the conclusion is restricted to perception-based evidence
Method transparency	Reviewers requested item sources, translation, adaptation, power analysis, common method bias, controls, and ethics	The method and Appendix report the measurement sources, adaptation protocol, sample adequacy, common method bias checks, and data transparency

Note: occupational safety and health (OSH); psychosocial safety climate (PSC); personal protective equipment (PPE)

This gap is important for Indonesia and East Java because safety systems in developing construction contexts often operate under uneven enforcement, limited training resources, high workforce mobility, and hierarchical supervision [7, 8].

A culture that declares safety as a priority may not influence perceived performance unless workers see clear psychosocial support in daily routines. The study therefore asks: how is safety culture associated with PSC and perceived safety performance in selected East Java mid-rise projects, and does PSC explain part of the association between safety culture and perceived safety performance? The objective is not to prove causal improvement. The objective is to test an association and mediation model that links organizational safety values with worker perceptions of safety system effectiveness in a construction safety engineering context.

2. LITERATURE REVIEW

2.1 From safety systems to psychosocial climate in construction

Construction safety management usually begins with engineering and administrative controls. These include hazard identification, work permits, PPE inspection, training, site induction, toolbox meetings, incident reporting, and supervisor monitoring. Recent studies on PPE non-compliance and fall prevention show that technical controls depend on management commitment, supervision, worker awareness, training, and risk communication [5, 6]. Studies on near-miss detection also show that leading indicators become useful only when workers report events and managers use the information for learning [7, 8]. These findings support a broader view of safety management in which physical hazards and psychosocial conditions interact.

Within this broader view, safety culture represents the general value system that guides how safety is prioritized [9]. Safety climate represents workers' shared perception of current safety priorities and practices [19]. PSC is narrower than both constructs because it focuses on the organizational climate for psychological health and psychosocial risk management [12, 20]. Perceived safety performance, as used in this study, refers to workers' assessment of the effectiveness and behavioural implications of the safety system rather than objective accident outcomes. Table 3 presents the conceptual boundaries used to prevent construct overlap.

The Job Demands-Resources perspective supports this distinction because it treats organizational resources as antecedents of strain, motivation, and work outcomes [22]. In high-risk construction activities, job demands include physical exertion, work at height, noise, heat, deadlines, and task interdependence. Organizational resources include supervision, communication, PPE availability, training, involvement, and support for reporting. PSC can be read as an upstream resource that shapes whether these resources are accessible to workers when they face demanding site conditions. This framing allows PSC to be analyzed as a construction safety mechanism rather than a purely psychological variable.

Table 3. Conceptual boundaries among core constructs

Construct	Core Focus	Construction Safety Expression	Boundary in This Study
Safety culture	Shared values, priorities, assumptions, and routines about safety	Management commitment, resource allocation, corrective action, worker consultation, and occupational safety and health (OSH) routines	Distal organizational condition that may shape PSC and perceived safety performance
Safety climate	Shared perception of how safety is prioritized in current operations	Daily supervisor behaviour, rule enforcement, training quality, and communication	Related to safety culture but not used as a separate latent construct in this model
Psychosocial safety climate (PSC)	Climate for psychological health and psychosocial risk prevention	Voice, fatigue management, pressure control, respectful reporting, and worker involvement	Mediator that links safety culture with perceived safety performance
Perceived safety performance	Worker perception of safety system effectiveness and behavioural consequences	Perceived contribution of OSH practices to safe conduct, morale, accident reduction, and system credibility	Perception-based outcome, not objective accident rate or inspection record

2.2 Safety culture and psychosocial safety climate

Safety culture is treated in this study as the deeper organizational pattern that shapes how managers and workers understand safety priorities, responsibilities, and acceptable conduct on site [17]. Safety climate is narrower because it captures workers' shared perception of how those priorities appear in daily practice, including supervision, communication, and enforcement [19]. PSC is different again because it focuses on whether organizational policies and managerial actions protect workers from psychosocial harm, such as excessive pressure, fatigue, role conflict, and fear of reporting [12]. These distinctions are necessary because a project may have formal safety rules but still fail to create a climate in which workers feel able to report fatigue or unsafe production pressure. In construction settings, this distinction becomes practical because written OSH procedures often reach workers through foremen, site supervisors, toolbox meetings, PPE allocation, and responses to reported hazards [5, 9, 11].

A stronger safety culture is expected to support PSC when safety values are translated into visible psychosocial risk-control practices. Management commitment is a core component of PSC, so workers are more likely to perceive strong PSC when supervisors treat psychological health and work pressure as legitimate safety concerns rather than personal weaknesses [12]. The JD-R framework also supports this path because organizational resources can reduce the impact of job demands before they become strain or unsafe behaviour [22]. In mid-rise projects, relevant demands include work at height, changing crews, repetitive lifting, heat exposure, accelerated schedules, and coordination across trades. These demands can become safety risks when fatigue is ignored, reporting is discouraged, or time pressure overrides hazard control, which is why PSC provides a plausible mechanism linking safety culture with workers' perceptions of safety management on site [13, 14, 21].

2.3 Safety culture and perceived safety performance

Safety culture is expected to be associated with perceived safety performance because workers evaluate project safety through repeated site practices rather than policy statements alone. These practices include whether PPE rules are enforced consistently, whether toolbox meetings provide task-specific hazard information, whether unsafe conditions are corrected promptly, and whether accident or near-miss reports receive feedback [5, 7, 8]. Safety performance in the behavioural literature is commonly linked with safety knowledge, motivation, compliance, and participation, so it should not be equated automatically with objective accident reduction in a cross-sectional survey [18, 23]. This distinction is important because the present study measures workers' evaluations of the safety system, not accident logs, near-miss databases, or independent inspection records. Therefore, the outcome is labelled perceived safety performance to align the construct with the evidence that was actually collected.

The use of perceived safety performance remains relevant for construction safety engineering because perception-based indicators can reveal how formal systems function in daily work. A site may report the existence of training, inspection checklists, and standard operating procedures, but workers may still perceive weak safety performance when PPE is unavailable, harness defects are not corrected, or supervisors tolerate shortcuts during work at height [5, 6]. In developing construction contexts, this issue is more sensitive because contractor resources, regulatory enforcement, and access to training can vary across projects and subcontracting arrangements [9, 10]. Safety leadership and project-owner maturity also influence how construction safety programs are communicated, monitored, and reinforced at the project level [11]. Thus, a positive safety culture should be reflected in workers' perceptions that the project safety system supports safer conduct, improves reporting, and reduces tolerance for unsafe practices [24-26].

2.4 Psychosocial safety climate and perceived safety performance

PSC is expected to relate positively to perceived safety performance because it addresses psychosocial conditions that can influence safe conduct during hazardous construction tasks. Workers who believe that supervisors listen to fatigue, stress, role conflict, and reporting concerns may be more willing to ask questions, report near misses, and resist unsafe shortcuts [13, 14]. This mechanism is especially relevant for work at height because alertness, communication, task clarity, and safety voice affect whether fall-prevention measures are used correctly [6]. PSC can also support PPE compliance because workers who feel psychologically safe are more likely to raise concerns about damaged harnesses, inadequate anchor points, heat stress, or pressure to rush a task [5]. These mechanisms explain why PSC is positioned as a proximal climate factor that may shape workers' evaluations of safety performance in construction projects [15, 16, 27].

Within the JD-R framework, PSC can be read as an upstream organizational resource that shapes how job demands and job resources are distributed before individual strain or motivation emerges [12, 22]. For construction workers, job demands may arise from physical load, production deadlines, subcontracting arrangements, changing site conditions, and coordination between crews. Job resources include supervisor support, training, communication, PPE availability, involvement in safety decisions, and permission to report unsafe conditions without retaliation. When PSC is strong, these resources become more accessible because workers receive clearer signals that psychological health and safety concerns are part of legitimate site management [12, 21]. This does not mean that PSC objectively reduces accident rates in a cross-sectional survey, but it can explain why workers perceive the safety system as more effective and more supportive of safe behaviour in the sampled mid-rise projects.

2.5 Hypothesis development

The mediation argument assumes that safety culture does not automatically become safe site practice. It needs an intermediate mechanism that translates organizational values into worker perceptions of support, communication, and involvement. PSC can serve that role because it links formal safety priorities with psychosocial resources that help workers speak, report, and participate under pressure. In the sampled projects, this pathway is plausible because workers operate in hierarchical, project-based, and time-pressured settings. Consequently, the conceptual model positions PSC as the intervening construct between safety culture and perceived safety performance.

The preceding review supports a model in which safety culture acts as the broader organizational condition, PSC functions as a psychosocial climate mechanism, and perceived safety performance represents workers' evaluation of project safety outcomes. The hypotheses are therefore stated as associative rather than causal claims, in line with the cross-sectional survey design. This formulation also responds to the measurement boundary between objective safety records and perception-based safety outcomes. Safety culture is expected to relate to PSC and perceived safety performance, while PSC is expected to relate to perceived safety performance and transmit part of the safety culture association. Accordingly, the study tests the following hypotheses before presenting the conceptual model in Figure 1.

H1: Safety culture has a significant positive association with PSC.

H2: Safety culture has a significant positive association with perceived safety performance.

H3: PSC has a significant positive association with perceived safety performance.

H4: PSC mediates the association between safety culture and perceived safety performance.

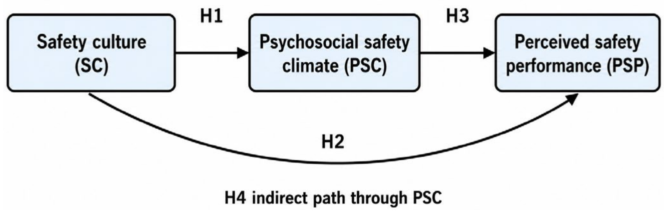

Figure 1. Conceptual model of the study

3. RESEARCH METHOD

3.1 Research design and setting

This study used a quantitative cross-sectional survey design. The design fits the objective of testing associations and mediation among safety culture, PSC, and perceived safety performance. It does not allow causal inference because all variables were collected from the same respondents at one period. The study setting consisted of six selected mid-rise building projects in four East Java cities: Malang, Jember, Kediri, and Surabaya. Data collection was conducted only after construction had reached above the fourth floor so that respondents had experienced work-at-height conditions relevant to the research model.

3.2 Population, sampling, and sample adequacy

The population comprised workers involved in the sampled mid-rise construction projects. Convenience sampling was used because project workers were geographically dispersed, no centralized workforce list was available, and employment patterns were temporary. This sampling strategy limits statistical generalization, but it is common in construction safety studies where probability sampling across active sites is difficult. A total of 150 questionnaires were distributed and 132 usable responses were obtained, yielding an 88% usable response rate. Eighteen questionnaires were excluded because core measurement items were incomplete.

Table 4. Study setting and inclusion logic

Element	Description	Reason for Inclusion
Project type	Mid-rise building construction projects with 4-8 floors	Work at height, temporary access, scaffolding, and vertical material movement were present
Locations	Malang, Jember, Kediri, and Surabaya, East Java	The cities represented dispersed active projects within the province
Project number	Six active construction projects	The sites provided access to workers across several trades
Respondents	Male frontline construction workers	The on-site workforce in the sampled projects was male at the time of data collection
Timing	December 2023 to November 2024	Project schedules were not synchronized, so collection followed project progress

Table 5. Respondent profile

Characteristic	Category	n	%
Gender	Male	132	100
Age	19-29	43	33
	30-39	43	33
	40-49	24	18
	50-59	16	12
	Above 60	6	5
Education	Elementary school	40	30
	Junior high school	47	36
	Senior high school	43	33
	Bachelor degree	2	2
Occupation	General labourers	37	28
	Formwork/carpentry	20	15
	Reinforcement/rebar	32	24
	Masonry/concrete	43	33
Work duration	<1 month	6	5
	1-2 months	76	58
	2-3 months	33	25
	>3 months	17	13
Project location	Malang	47	36
	Jember	39	30
	Kediri	23	17
	Surabaya	23	17

Table 4 presents the study setting and inclusion logic used to define the empirical context of the sampled projects, and Table 5 reports the demographic and work-related profile of the respondents used to contextualize the PLS-SEM results.

Sample adequacy was assessed more carefully than the simple 10-times rule. An a priori power logic was applied using a medium effect size assumption ($f2 = 0.15$), $\alpha = 0.05$, power = 0.80, and two predictors directed at the main endogenous construct. Under this assumption, the minimum required sample for a multiple regression equivalent is below the achieved sample size of 132. The achieved sample therefore provides acceptable statistical power for the focal model. Nevertheless, the non-probability design, all-male sample, and project-specific context remain limitations that are explicitly acknowledged in the interpretation.

3.3 Instrument development and adaptation

The questionnaire measured three constructs. Safety culture was measured with 15 items adapted from construction safety culture and OSH management system literature. PSC was measured with 12 items based on the PSC-12 framework, which captures management commitment, psychological health priority, communication, and worker participation. Perceived safety performance was measured with seven items that reflect worker perceptions of safety system effectiveness and its contribution to safe conduct, accident reduction, morale, organizational image, and cost-related outcomes. Because these items are perception-based, the construct is named perceived safety performance throughout the revised article.

Table 6 summarizes the measurement sources and the adaptation focus for each construct in the construction site context.

Table 7 presents the translation, expert review, back-translation, and pilot-testing protocol used to adapt the questionnaire.

Table 6. Measurement sources and adaptation focus

Construct	Items	Primary Source Logic	Adaptation to Construction Site Context
Safety culture	15	Safety culture and occupational safety and health (OSH) management system dimensions [9-12, 19]	Managerial response, corrective action, safety priority, resources, consultation, and supervisor practice
Psychosocial safety climate	12	PSC-12 dimensions [13, 14]	Psychological health priority, communication, involvement, fatigue, pressure, and reporting voice
Perceived safety performance	7	Safety performance and safety system outcomes [18, 21, 23, 24]	Perceived effect of safety systems on safe conduct, incident reduction, morale, image, and cost control

Table 7. Translation and adaptation protocol

Step	Action	Quality Check
Forward translation	The English questionnaire was translated into Bahasa Indonesia	Technical occupational safety and health (OSH) terms were simplified for frontline workers
Expert review	Construction safety and psychology experts reviewed wording	Items were checked for conceptual fit and field clarity
Back-translation	The Bahasa Indonesia version was translated back into English	Meaning differences were discussed and corrected
Pilot test	Thirty workers from a non-sampled project completed the questionnaire	Ambiguous wording was revised and reliability exceeded 0.70

The adaptation process followed four steps. First, the English instrument was translated into Bahasa Indonesia. Second, a back-translation was conducted to check meaning equivalence. Third, construction safety and occupational psychology reviewers examined whether the items were understandable for workers with diverse education levels. Fourth, a pilot test with 30 workers from a non-sampled project was used to identify unclear terms and estimate internal consistency. The pilot Cronbach's alpha coefficients exceeded 0.70 for all constructs, supporting the use of the instrument in the main survey.

3.4 Data collection procedure

Questionnaires were administered on site during weekly safety briefings held every Friday at 07:00 AM. This timing was selected because workers were already gathered for safety communication and standard work generally began at 07:30 AM. Each session lasted approximately 20 minutes and included an explanation of the study purpose, participation rights, confidentiality, and questionnaire completion. The researcher stayed at the site to clarify items and reduce missing responses. Participation was voluntary, and workers could decline without any effect on their employment or relationship with the project.

3.5 Data analysis

Data were analyzed with SmartPLS 4.0 using PLS-SEM. The method was selected because the study examines a mediation model, uses a moderate sample size, and focuses on explanation and prediction rather than covariance-based model fit [28]. The measurement model was assessed through outer loadings, Cronbach's alpha, composite reliability, average variance extracted (AVE), and HTMT. Indicators below 0.70 were retained when they remained conceptually important and when removal did not improve reliability or AVE. The structural model was assessed using path coefficients, t-values, p-values, R2, f2 interpretation, Q2predict, and CVPA.

The mediation test used bootstrapped indirect effects, total effect, VAF, and upsilon mediation effect size [29]. Common method bias was addressed procedurally through anonymity, item clarification, and separation of construct wording, and statistically through Harman's single-factor screening and full collinearity variance inflation factor (VIF) diagnostics [30]. Age, education, occupation, project location, and work duration were considered as contextual control variables in the interpretation because small cells within some categories reduce the stability of full dummy-variable modelling. This approach does not remove the limitation of self-report data. It makes the boundary of the evidence explicit.

3.6 Ethics and data transparency

The study involved workers' perceptions of psychosocial climate and workplace safety, so ethical safeguards were integrated into the field survey procedure. The survey was non-invasive and did not involve medical intervention, clinical procedures, biological samples, or the collection of sensitive legal information. No formal ethics approval number was issued for this questionnaire-based study. During data collection, respondents received an explanation of the study purpose, voluntary participation, confidentiality, the right to decline or stop participation, and the academic use of the data. A written information and informed consent form was prepared during the revision stage to document these ethical safeguards and to clarify the rights of construction worker respondents.

Participation was voluntary, and workers could refuse to participate, skip any question, or withdraw without penalty or consequence for their employment or relationship with the contractor or project management. Questionnaire responses were used only for academic research and were analyzed in aggregate form. No names, payroll numbers, or direct identifiers were recorded in the analytical dataset. If any signed consent documentation is retained, it is stored separately from questionnaire responses and is not linked to the dataset used for analysis. Completed questionnaires are stored securely with restricted access, while digital data files are kept on a password-protected device accessible only to the principal researcher and authorized research team members. The data will be retained for five years and then securely disposed of.

4. RESULTS AND DISCUSSION

4.1 Measurement quality and construct validity

Table 8 presents the measurement model assessment. All constructs showed acceptable internal consistency, with Cronbach's alpha and composite reliability values above 0.70. AVE values exceeded 0.50, supporting convergent validity. Some loadings were below 0.70 but remained above 0.60 and were retained because they represented important elements of the adapted construction safety context. HTMT values were below 0.90, suggesting acceptable discriminant validity among safety culture, PSC, and perceived safety performance.

The measurement results also support the reviewer-requested conceptual distinction among constructs. Safety culture, PSC, and perceived safety performance are correlated, but the HTMT values do not indicate that they are the same construct. This is important because PSC could otherwise appear too close to safety culture. The retained items show that safety culture reflects broader safety values and OSH management routines, while PSC reflects psychosocial protection, communication, and worker involvement. Perceived safety performance then captures workers' assessment of how safety arrangements are functioning in the project setting.

Table 8. Measurement model assessment

Construct	Items	Loading Range	Cronbach Alpha	CR rhoA	CR rhoC	AVE	Highest HTMT
Safety culture	15	0.609-0.769	0.929	0.931	0.938	0.501	0.862
Psychosocial safety climate	12	0.672-0.778	0.910	0.911	0.924	0.502	0.862
Perceived safety performance	7	0.673-0.763	0.850	0.851	0.886	0.526	0.851

Note: composite reliability (CR); average variance extracted (AVE); heterotrait-monotrait ratio (HTMT)

4.2 Common method bias, collinearity and contextual controls

Because all variables came from the same questionnaire at the same time, common method bias required explicit treatment. Procedurally, respondents were informed that answers were anonymous and would not affect employment. The researcher clarified item meaning without directing responses. Statistically, Harman's single-factor test showed that the first unrotated factor explained 27.64% of total variance, below the 50% screening threshold. Full collinearity VIF values were below 3.3, suggesting that common method bias was unlikely to dominate the model, although it cannot be fully ruled out.

Table 9 reports the common method bias and collinearity diagnostics used to evaluate the possibility of inflated self-report relationships.

The contextual variables also help interpret the model. The sample includes many workers with elementary or junior high school education and many respondents with one to two months of project duration. These characteristics may increase reliance on supervisors, toolbox communication, and repeated safety demonstrations. Occupation also matters because formwork, reinforcement, concrete, and general labour tasks involve different exposures to height, material movement, and time pressure. The study therefore avoids claiming universal construction-sector generalization and restricts inference to the sampled East Java mid-rise projects.

Table 9. Common method bias and collinearity diagnostics

Diagnostic	Result	Interpretation
Harman single-factor test	First factor = 27.64%	Below 50%; no dominant single-factor pattern
Inner model variance inflation factor (VIF)	1.000-2.786	Below 3.0; no serious structural collinearity
Full collinearity VIF screening	All values below 3.3	Common method bias is unlikely to severely inflate estimates
Control-variable review	Age, education, occupation, location, and work duration considered contextually	Demographic restrictions are discussed as boundaries rather than causal controls

4.3 Structural path results

Table 10 reports the direct structural path coefficients and hypothesis-testing results for the proposed model. Safety culture had a strong positive association with PSC (beta = 0.801, t = 19.283, p < 0.001), supporting H1. Safety culture also had a positive association with perceived safety performance (beta = 0.347, t = 2.240, p = 0.025), supporting H2. PSC had a positive association with perceived safety performance (beta = 0.476, t = 3.438, p = 0.001), supporting H3. These results are interpreted as associations because the cross-sectional design cannot establish temporal ordering.

The strongest direct result is the association between safety culture and PSC. This pattern suggests that workers who perceive stronger safety values, clearer communication, and better safety consultation also perceive stronger psychosocial protection. The result is consistent with the idea that PSC develops when management translates safety priorities into supportive supervision and involvement. In a construction context, this means that safety culture is not only a matter of rules and documents. It also appears through whether supervisors listen to fatigue concerns, respond to reporting, and allow workers to raise work-at-height risks without blame.

Table 10. Structural model assessment

Hypothesis	Path	VIF	β	t	p	Result
H1	SC → PSC	1	0.801	19.283	<0.001	Supported
H2	SC → PSP	2.786	0.347	2.24	0.025	Supported
H3	PSC → PSP	2.786	0.476	3.438	0.001	Supported

Note: confidence intervals (CI) were obtained from the bootstrapping procedure; variance inflation factor (VIF); safety culture (SC); Psychosocial safety climate (PSC); perceived safety performance (PSP)

The H1 result is particularly important because it explains why PSC should not be treated as a duplicate of safety culture. Safety culture represents the broader value system that defines whether safety is prioritized over production pressure, while PSC captures the perceived protection of psychological health within that system. In the sampled projects, this distinction is relevant because workers often receive safety instructions through supervisors rather than formal corporate channels. When supervisors respond seriously to fatigue, unclear instructions, fear of reporting, and pressure during high-risk tasks, workers are more likely to interpret safety culture as a credible psychosocial resource. This interpretation strengthens the theoretical position that PSC is an intervening climate mechanism rather than an additional label for safety culture [13-15, 21].

The H2 and H3 findings also need to be read together rather than separately. The direct association between safety culture and perceived safety performance indicates that formal safety values, procedures, consultation, and resource allocation remain relevant to workers' safety evaluations. However, the stronger PSC to perceived safety performance path suggests that workers may judge project safety more favourably when they feel psychologically safe to report hazards, ask for clarification, and resist unsafe pressure. This pattern is plausible in mid-rise construction, where work at height, material handling, scaffolding access, and concrete or rebar activities require both technical compliance and worker voice. The result therefore supports a dual interpretation: safety culture provides the formal safety foundation, while PSC appears to make that foundation more visible and usable during daily site operations [27].

The mediation analysis supports H4. The indirect effect from safety culture to perceived safety performance through PSC was significant (beta = 0.381, t = 3.446, p = 0.001). The direct effect remained significant, so the evidence supports partial mediation rather than full mediation. The total effect was 0.728 and VAF was 52.3%, indicating that slightly more than half of the total association operated through PSC. These mediation and predictive-performance results are summarized in Table 11. The upsilon mediation effect size was 0.145, which is above the medium threshold often used for mediation effect interpretation [29].

The predictive assessment is important for construction safety engineering because a useful model should not only explain theoretical relationships but also support risk-informed managerial attention. The R2 values indicate that the model explains substantial variance in PSC and perceived safety performance. The Q2predict and CVPAT results show that the model has predictive relevance beyond simple benchmark approaches [31]. However, predictive relevance does not mean objective accident reduction. It means that the latent variables are useful for explaining and predicting workers' perception-based assessment of safety system effectiveness within the sampled projects.

The mediation result gives the model its main explanatory value. A VAF of 52.3% indicates that PSC accounts for a substantial part of the association between safety culture and perceived safety performance, although the remaining direct effect shows that other mechanisms also operate. These mechanisms may include technical training, PPE availability, safety inspection discipline, work-permit control, and supervisor enforcement. The finding is therefore consistent with partial mediation, not a claim that PSC alone explains construction safety outcomes. This balanced interpretation is important for readers because construction safety performance depends on combined organizational, behavioural, and engineering controls rather than a single psychosocial pathway.

The SmartPLS model output in Figure 2 illustrates the estimated structural paths, indicator loadings, and explained variance values used to interpret the PLS-SEM results.

Table 11. Mediation and predictive performance

Component	Result	Interpretation
Specific indirect effect	SC → PSC → PSP: beta = 0.381, t = 3.446, p = 0.001, 95% CI = 0.163-0.599	PSC significantly mediates the association between safety culture and perceived safety performance
Direct effect	SC → PSP: beta = 0.347, p = 0.025	Direct association remains significant
Total effect and VAF	Total effect = 0.728; VAF = 52.3%	Partial mediation with a substantive indirect pathway
R2	PSC = 0.641; PSP = 0.612	Moderate-to-substantial explanatory power
Q2predict	PSC = 0.621; PSP = 0.493	Positive predictive relevance
CVPAT	Overall delta loss vs IA = -0.253, p < 0.001; vs LM = -0.114, p < 0.001	PLS model outperformed benchmark models

Note: safety culture (SC); Psychosocial safety climate (PSC); perceived safety performance (PSP)

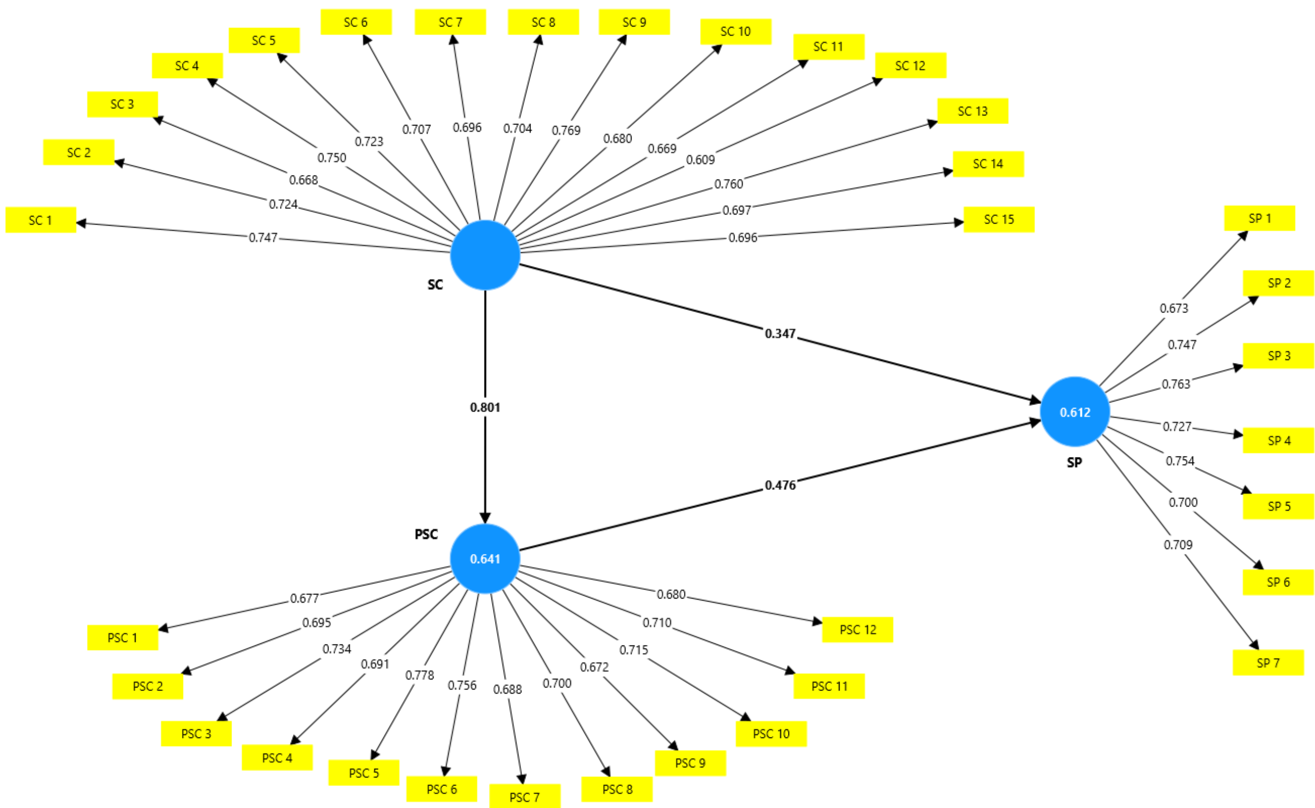

Figure 2. PLS-SEM model structure from smart PLS output

Note: The SP label in the SmartPLS figure refers to perceived safety performance (PSP) in the revised manuscript

4.4 Discussion of the construction safety engineering context

The findings move the article closer to construction safety engineering by showing how psychosocial climate can operate inside technical safety routines. Work at height is a high-risk activity that relies on physical controls, such as guardrails, harnesses, access planning, and safe platforms. Yet these controls can fail when workers are tired, rushed, unclear about task sequencing, or reluctant to speak. The positive PSC path suggests that workers' perception of psychosocial support may help explain whether formal safety arrangements are viewed as credible and effective. This interpretation aligns with current construction studies that connect fall prevention, PPE adoption, near-miss reporting, supervision, and human performance factors [24, 32].

The weaker direct path from safety culture to perceived safety performance also matters. It implies that general safety values may not be enough to shape workers' perceptions of safety outcomes when site conditions are unstable. Safety culture needs operational and psychosocial channels that are visible during toolbox meetings, permits, inspections, and reporting. PSC appears to be one such channel because it makes pressure, fatigue, and voice part of safety management rather than private worker problems. This is why the indirect effect exceeded the direct effect in the model.

The results also clarify the boundary of perceived safety performance. The study did not record accident rates, near-miss counts, unsafe-act observations, PPE compliance audits, or inspection scores. It therefore cannot show that PSC objectively reduces injuries or raises site safety performance. The evidence shows that workers who perceive stronger safety culture and PSC also report stronger perceived safety system performance. This distinction is important for the revised conclusion, because a cross-sectional self-report study should not make causal claims about incident reduction.

The construction meaning of these findings is strongest when PSC is connected to high-risk task preparation. Before work at height, workers must understand the task sequence, available fall-prevention controls, PPE condition, access route, weather exposure, and rescue procedure. These technical controls can be undermined when workers are fatigued, pressured to finish quickly, or unwilling to report damaged equipment. PSC can address this gap by making fatigue, pressure, and reporting confidence part of the same safety conversation as guardrails, harnesses, anchor points, and scaffolding inspections. In this sense, PSC functions as a leading perception-based signal that may alert project managers to weaknesses in the social conditions surrounding technical safety controls [24, 32].

The respondent profile helps explain why this pathway may be salient in the sampled projects. Many workers had limited formal education and short project tenure, which may reduce familiarity with written OSH procedures and increase dependence on verbal briefings. Several occupational groups in the sample, including formwork, reinforcement, concrete, and general labour tasks, also face changing work zones and task sequences. Under these conditions, safety communication is not a one-time training event but a repeated supervisory process. The results suggest that perceived safety performance is more likely to be favourable when workers experience that process as supportive, clear, and responsive rather than punitive or purely compliance-oriented.

4.5 Practical recommendation for project safety management

The practical implications should not remain at the level of general management commitment. The findings suggest that project teams can insert PSC into existing construction safety routines without replacing engineering controls. Toolbox meetings can include short questions on fatigue, time pressure, task clarity, and fear of reporting. Work-at-height permits can include a quick psychosocial readiness check before workers enter scaffolding, formwork, or slab-edge areas. PPE inspections can also ask whether workers are alert, trained for the task, and comfortable reporting defects in harnesses, helmets, access routes, or guardrails.

Projects should also establish confidential channels for psychosocial hazard reporting. These channels can capture pressure to rush, unsafe instructions, fatigue, supervisor intimidation, and near-miss events that are not recorded in conventional accident logs. Site supervisors should review these reports during weekly OSH coordination meetings and link them to corrective actions. A simple dashboard can track PSC-related leading indicators, such as number of fatigue observations, number of near-miss reports, number of toolbox PSC checks, and follow-up completion rate. Table 12 summarizes the recommendations derived from the findings.

Table 12. Construction safety recommendations derived from the findings

Key Issue	Recommended Intervention	Expected Safety Management Contribution
Fatigue and pressure before work at height	Add fatigue, time-pressure, and task-clarity checks to toolbox meetings and work-at-height permits	Makes psychosocial risk visible before elevated work begins
Weak reporting voice	Create confidential or anonymous channels for stress, pressure, and near-miss reporting	Reduces fear of blame and supports proactive hazard learning
PPE compliance depends on worker state	Combine PPE inspection with questions on alertness, training, and comfort in reporting equipment defects	Connects physical control with worker readiness
OSH system focused on lagging indicators	PSC leading indicators to safety dashboards	Helps managers identify pressure, fatigue, and communication problems before incidents occur
Supervisor role in daily safety	Train supervisors to respond constructively to psychosocial reports and unsafe-work concerns	Strengthens the pathway from safety culture to PSC

Note: occupational safety and health (OSH); psychosocial safety climate (PSC); personal protective equipment (PPE)

4.6 Implications for occupational safety and health system integration

The findings also suggest that PSC can be integrated into existing OSH systems as a leading indicator rather than introduced as a separate psychological program. Project teams can connect PSC monitoring with toolbox meetings, work-at-height permits, PPE inspection forms, near-miss reports, supervisor safety walkdowns, and safety training evaluations. This approach allows psychosocial hazards such as fatigue, time pressure, fear of reporting, and unclear task instructions to be reviewed alongside physical hazards before high-risk work begins. The integration is practical for mid-rise projects because it uses routines that already exist on site and does not require a new parallel reporting system. However, PSC indicators should complement objective safety evidence, including accident rates, PPE compliance audits, unsafe-act observations, inspection records, and near-miss logs.

This integration also improves the practical value of perceived safety performance. When workers report better perceived safety performance, managers should not treat the score as proof that the site is objectively safe. Instead, the score should trigger comparison with leading and lagging indicators from the OSH system. For example, high perceived safety performance combined with low near-miss reporting may indicate underreporting rather than strong safety. Conversely, high near-miss reporting with strong PSC may show that workers are willing to speak before incidents occur. This combined reading can help project managers interpret survey evidence more responsibly and avoid overclaiming from self-reported data.

4.7 Implications for occupational safety and health system integration

Several limitations must guide interpretation. First, the cross-sectional design prevents causal inference, so the study should be read as evidence of association and mediation. Second, all variables were self-reported, which can inflate relationships even after procedural and statistical checks. Third, the sample was limited to 132 male workers from six selected mid-rise projects in East Java, so the findings do not represent all Indonesian construction workers or all project types. Fourth, the study did not use objective safety indicators such as accident records, near-miss logs, PPE compliance observations, work-permit audits, or inspection records.

These limitations do not invalidate the model, but they define its scope. The study offers a perception-based explanation of how safety culture, PSC, and perceived safety performance are associated in a specific construction context. It also provides a practical bridge between organizational climate theory and site safety management routines. Future research should extend the model using longitudinal data, multiple project types, supervisor-rated safety behaviour, and objective indicators. Such evidence would allow stronger conclusions about whether PSC predicts later changes in PPE use, near-miss reporting, unsafe acts, and accident outcomes.

5. CONCLUSIONS

This study examined the mediating role of PSC in the association between safety culture and perceived safety performance among workers from six selected mid-rise construction projects in East Java, Indonesia. The results support all four hypotheses. Safety culture was positively associated with PSC and perceived safety performance, while PSC was positively associated with perceived safety performance. The mediation analysis showed that PSC partially mediated the association between safety culture and perceived safety performance, with VAF of 52.3%. The findings therefore support a cautious interpretation that PSC may help explain how safety culture is reflected in workers' perception of safety system effectiveness.

5.1 Theoretical and practical implications

The theoretical contribution lies in clarifying the boundary between safety culture, safety climate, PSC, and perceived safety performance. Safety culture represents broad organizational safety values and routines, while PSC focuses on psychosocial risk prevention, worker voice, communication, and psychological protection. By placing PSC between safety culture and perceived safety performance, the study extends the Job Demands-Resources perspective into a developing-economy construction context. The practical contribution lies in translating PSC into construction safety engineering routines. Project managers can use PSC checks in toolbox meetings, work-at-height permits, PPE inspections, supervisor training, and confidential reporting systems.

5.2 Limitations and future research

The conclusion is limited to perceived safety performance because the study did not collect objective accident data, near-miss logs, inspection records, or observed PPE compliance. The design was cross-sectional, the sample was non-probability based, and all respondents were male workers from selected East Java mid-rise projects. Future research should combine PSC measurement with site inspection records, accident and near-miss data, work-at-height permit audits, and supervisor-rated behaviour. Longitudinal designs are needed to examine whether changes in PSC precede later changes in safety behaviour and incident outcomes. Comparative studies across provinces, project sizes, and contract types would also strengthen external validity.

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ETHICS CONSIDERATIONS AND INFORMED CONSENT

This study did not involve medical intervention, clinical procedures, physical intervention, biological sampling, or the collection of personally identifiable sensitive data. No formal ethics approval number was issued for this non-invasive questionnaire-based survey. Ethical safeguards were implemented through voluntary participation, informed consent, confidentiality, the right to withdraw, and secure data management. During the field survey, respondents were informed about the study objectives, questionnaire procedures, minimal risks, confidentiality protection, academic data use, and contact information for the principal researcher. A written information and informed consent form was prepared during the revision stage to document these safeguards and clarify respondent rights.

Participation was entirely voluntary, and respondents could refuse to participate, skip any question, or withdraw at any time without penalty or consequence for their employment or project relationship. Questionnaire responses were analyzed and reported only in aggregate form. No names, payroll numbers, or direct identifiers were entered into the analytical dataset. If any signed consent documentation is retained, it is stored separately from questionnaire responses and is not linked to the dataset used for analysis. Completed questionnaires and digital files are stored securely with restricted access and will be retained for five years before secure disposal.

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APPENDIX

Questionnaire items and sources

All items used a five-point Likert scale from 1 = strongly disagree to 5 = strongly agree. The items below present the adapted English wording used for transparency. The Bahasa Indonesia field version followed the forward-backward translation and pilot-testing process described in the Methods section.

Table A1. Questionnaire items and sources

Code	Adapted Item Wording	Construct Source
SC1	Management gives priority to safety in daily construction activities.	Safety culture
SC2	Supervisors respond quickly when workers identify unsafe conditions.	Safety culture
SC3	Safety is not sacrificed to finish work faster.	Safety culture
SC4	The project provides enough time to work safely.	Safety culture
SC5	The project provides adequate PPE and safety equipment.	Safety culture
SC6	Workers are consulted before important safety decisions are made.	Safety culture
SC7	Safety training helps workers understand site hazards.	Safety culture
SC8	Supervisors correct unsafe acts in a fair manner.	Safety culture
SC9	Workers are encouraged to report near misses.	Safety culture
SC10	Corrective actions are taken after safety problems are reported.	Safety culture
SC11	Safety information is communicated clearly during toolbox meetings.	Safety culture
SC12	The project monitors safety practices consistently.	Safety culture
SC13	Workers can stop work when serious risk is present.	Safety culture
SC14	Project leaders show commitment to accident prevention.	Safety culture
SC15	Safety rules are applied consistently across work groups.	Safety culture
PSC1	Senior management shows commitment to workers psychological health.	PSC-12 adapted
PSC2	Psychological health is treated as an important part of safety.	PSC-12 adapted
PSC3	Management acts when work pressure creates safety concerns.	PSC-12 adapted
PSC4	Communication about stress and fatigue is open on this project.	PSC-12 adapted
PSC5	Workers are encouraged to speak about psychosocial risks.	PSC-12 adapted
PSC6	Supervisors listen when workers report fatigue or pressure.	PSC-12 adapted
PSC7	Workers are involved in preventing psychosocial hazards.	PSC-12 adapted
PSC8	The project considers workload when planning tasks.	PSC-12 adapted
PSC9	Workers can report pressure without fear of blame.	PSC-12 adapted
PSC10	Psychological health concerns are discussed in safety communication.	PSC-12 adapted
PSC11	Management considers worker well-being when making decisions.	PSC-12 adapted
PSC12	The project takes action to reduce harmful work pressure.	PSC-12 adapted
PSP1	The project safety system helps workers perform tasks safely.	Perceived safety performance
PSP2	The safety system supports correct PPE use.	Perceived safety performance
PSP3	The safety system helps reduce unsafe acts.	Perceived safety performance
PSP4	The safety system helps reduce accident risk.	Perceived safety performance
PSP5	The safety system improves worker morale.	Perceived safety performance
PSP6	The safety system improves the project safety image.	Perceived safety performance
PSP7	The safety system helps reduce costs related to unsafe work.	Perceived safety performance