

Construction Safety Personnel at a Crossroads: Challenges and Organisational Interventions in Malaysia

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DOI: <https://doi.org/10.51584/IJRIAS.2026.11080133>

Received: 02 September 2026; Accepted: 07 September 2026; Published: 18 September 2026

ABSTRACT

Construction safety personnel are responsible for translating statutory requirements and organisational policies into daily site practices, yet their effectiveness depends on the resources, authority and cooperation available to them. This study examined the challenges encountered by construction safety personnel and identified organisational interventions that could strengthen their performance in the Malaysian construction industry. A quantitative cross-sectional survey was conducted among 54 construction practitioners with safety-related knowledge, experience or responsibilities in Penang, Malaysia. The questionnaire measured four domains using a seven-point Likert scale: current safety-compliance conditions, challenges affecting safety personnel, organisational interventions and expected safety outcomes. Data were analysed using frequencies, mean scores, standard deviations and Cronbach's alpha. Limited resources ranked first among the assessed challenges (mean = 5.20), followed by communication and language barriers (mean = 5.17). Adapting to technological advancements and balancing safety with productivity were jointly ranked third, with both recording a mean of 5.15. Clear roles and responsibilities and training and education were jointly ranked as the most strongly supported interventions, with both recording a mean of 5.56, followed by technology adoption (mean = 5.43) and leadership support (mean = 5.39). Prevention of accidents, proactive hazard mitigation and control, and timely hazard identification and risk assessment were jointly ranked as the leading expected outcomes, with each recording a mean of 5.70. Internal-consistency coefficients ranged from 0.981 to 0.992, indicating highly consistent responses, although these values may also reflect similarity among some questionnaire items. Drawing on these results, the study proposes an exploratory conceptual framework for role realisation that organises the identified factors into role inhibitors, role stimulators, and pessimistic and optimistic organisational conditions. The framework provides a structured interpretation of the descriptive findings rather than a statistically tested causal model. The findings indicate that the organisational contribution of safety personnel may be strengthened through clear authority, adequate resources, continuing competency development and management support. The study provides context-specific evidence from construction practitioners in Penang and establishes a basis for wider investigation across the Malaysian construction industry.

Keywords: construction safety personnel, occupational safety and health, safety management, organisational interventions, Malaysian construction industry

INTRODUCTION

Construction work combines temporary workplaces, changing work fronts, multiple employers, heavy equipment, work at height and frequent interaction between workers and machinery. These features create safety risks that cannot be controlled through written rules alone. Effective control depends on how consistently hazards are recognised, information is communicated, corrective action is authorised and preventive measures are maintained during production. Construction safety personnel therefore occupy an operational position between regulatory requirements, organisational priorities and site-level behaviour.

The scale of Malaysian construction activity adds practical importance to this issue. The value of construction work completed in Malaysia reached RM178.6 billion in 2025, representing annual growth of 12.5% (Department of Statistics Malaysia [DOSM], 2026). Expansion in building, civil engineering and specialised construction increases the number and diversity of workplaces that require competent safety supervision. Recent reviews and empirical studies show that actual performance is shaped by management commitment, safety climate, planning, communication, supervision, worker participation and resource provision (Kima et al., 2026; Shohet et al., 2025; Xia et al., 2023). Within the Malaysian context, inadequate safety planning, management failure, insufficient safety promotion, poor supervision and enforcement, and limited experience have been identified as important influences on construction health and safety practices (Oni et al., 2024). Research involving Malaysian mass rapid transit projects has also emphasised the value of coordinated contractor action, training, technology and emergency preparedness (Masrom et al., 2025). These findings direct attention towards the organisational conditions that support the work of construction safety personnel.

Safety and Health Officers, Site Safety Supervisors and other personnel with assigned safety responsibilities perform inspections, communicate safe work requirements, support hazard identification and risk assessment, maintain records, investigate incidents and coordinate responses with management, workers, subcontractors and regulators. Their influence, however, is not determined solely by technical knowledge. Limited budgets, insufficient staffing, compressed programmes, fragmented subcontracting, language differences and competing production priorities can restrict these duties.

Recent construction safety-climate research emphasises that communication, supervisory practice and organisational arrangements jointly shape how safety expectations are understood and enacted (Kima et al., 2026; Xia et al., 2023). Evidence from Malaysian construction sites further indicates that workers' safety knowledge, attitudes and practices vary according to individual characteristics and their interaction with behaviour-based safety arrangements (Saedi et al., 2023). Safety personnel must therefore communicate and implement safety requirements within workforces that differ in experience, knowledge and behavioural responses.

Previous research has examined project safety, safety climate and worker safety behaviour. Recent reviews consistently identify organisational, managerial and individual determinants rather than a single explanation for weak performance (Xia et al., 2023). Studies of safety leadership further demonstrate that supervisory conduct and perceived employer obligations are connected to worker behaviour and the safety climate experienced on site (Elosta & Alzubi, 2024; Sankar et al., 2024).

Recent Malaysian studies have evaluated general health and safety practices, worker safety behaviour and project-level improvement measures (Masrom et al., 2025; Oni et al., 2024; Saedi et al., 2023). However, limited attention has been given to the challenges encountered by the personnel responsible for coordinating and implementing construction safety requirements. The relationship between these challenges, possible organisational responses and expected improvements in safety performance also requires further examination. Accordingly, this study aimed to examine challenges affecting construction safety personnel and identify organisational interventions that could strengthen their role in the Malaysian construction industry.

The objectives were: (1) to rank the principal challenges encountered by construction safety personnel; (2) to rank interventions for reinforcing and empowering their role; and (3) to propose an evidence-informed conceptual framework that organises the identified challenges, organisational responses and intended safety outcomes. The study uses descriptive rankings to establish the relative importance of the assessed factors and organise them within an exploratory conceptual framework for role realisation. The paper contributes context-specific empirical evidence and translates the ranking results into a practical framework for contractors, clients, project managers and safety practitioners.

LITERATURE REVIEW

Construction Safety Management and Personnel

Occupational safety and health management requires coordinated arrangements for leadership, worker participation, hazard identification, operational control, performance evaluation and improvement. On construction projects, these arrangements must function within temporary and evolving production conditions. Safety personnel connect policy with site operations by observing work, advising managers, coordinating controls and communicating with workers. Their effectiveness therefore reflects both personal competence and the organisational conditions in which that competence is applied.

Xia et al. (2023) found that construction safety-climate research spans organisational, group and individual levels, with management commitment, communication, supervision and worker involvement recurring across measurement frameworks. Research on small and medium construction enterprises likewise shows that organisational scale and operational structure affect how safety climate is formed and maintained (Kima et al., 2026). High-rise projects add vertical logistics, overlapping activities and complex coordination, making consistent supervisory arrangements particularly important (Shohet et al., 2025). Malaysian research has produced comparable findings, particularly concerning inadequate safety planning, management failure, poor supervision and enforcement, and insufficient experience (Oni et al., 2024). These findings support examining safety personnel as part of a wider work system. A competent officer may identify a hazard correctly but remain unable to secure corrective action if authority, resources or production support are absent.

Challenges Confronting Safety Personnel

Resource limitations can concern staffing, time, training budgets, monitoring equipment and access to technical support. When one individual covers several work fronts or projects, inspection and follow-up may become selective rather than systematic. Resource pressure can also make safety activities appear secondary to immediate production demands. Recent safety-climate research identifies management commitment, supervisory practice, communication and organisational arrangements as mutually dependent contributors to safe behaviour (Kima et al., 2026; Xia et al., 2023). Oni et al. (2024) similarly found that deficiencies in planning, management, supervision and experience affected health and safety practices in the Malaysian construction industry. Resource adequacy must therefore be considered in relation to the wider organisational arrangements that determine how safety duties are planned, supported and enforced. Insufficient provision in one area can weaken several safety functions at once.

Communication is another persistent constraint. Construction teams are frequently assembled from different organisations, trades and linguistic backgrounds. Safety-climate studies consistently treat the communication of expectations and supervisor-worker interaction as central features of site safety (Kima et al., 2026; Xia et al., 2023). Saedi et al. (2023) found that workers' safety knowledge, attitudes and practices at Malaysian construction sites differed according to demographic characteristics and interaction with behaviour-based safety programmes. This variation indicates that safety communication and training may require adaptation to the knowledge, experience and characteristics of the intended workforce. For safety personnel, the problem extends beyond transmitting information. They must verify understanding, adapt messages to literacy and language needs, and maintain consistency between management instructions and site practice.

Safety personnel must also respond to technological and regulatory change. Digital reporting, mobile inspection, wearable devices, computer vision and immersive training can improve the speed or quality of hazard information, but adoption introduces training, compatibility and acceptance requirements. Zhang et al. (2022) found that perceived usefulness, ease of use and other acceptance factors shape willingness to adopt virtual reality for construction safety training. Comparative evaluation by Han et al. (2022) also showed the importance of assessing both learning processes and outcomes rather than assuming that a digital

format is inherently effective. More recent work has extended this area to biometric forecasting of learning performance and mobile immersive hazard-recognition systems (Choi et al., 2023; Ozel & Pekerikli, 2025).

Authority and leadership influence whether safety advice produces action. Safety leadership is associated with the climate experienced on construction sites and with workers' safety behaviour (Elosta & Alzubi, 2024; Sankar et al., 2024). Management support is therefore expressed through decisions about resources, schedules, enforcement and the standing given to safety personnel, not merely through policy statements. Where production decisions repeatedly override safety advice, formal responsibility may remain disconnected from practical influence. This interpretation is supported by Malaysian evidence identifying management failure and poor supervision and enforcement as important constraints on construction safety practice (Oni et al., 2024). Masrom et al. (2025) also placed contractor responsibility and coordinated management action at the centre of their safety improvement framework for Malaysian mass rapid transit projects.

Organisational Interventions

Effective interventions should correspond to the constraints that safety personnel experience. Clear job descriptions and reporting lines can reduce ambiguity and establish the authority to stop or correct unsafe work. Training should maintain knowledge of legislation, risk controls, communication and emerging technologies. Rokooei et al. (2023) documented the application of virtual reality in construction safety training, while Uddin et al. (2023) examined the potential for generative artificial intelligence to support hazard recognition and safety education. Liao et al. (2025) further examined the influence of safety capacity and personalised training on construction workers' hazard recognition, supporting the use of training that responds to differences in competence and experience. These approaches remain dependent on suitable content, user competence and organisational follow-through. Training measures are more credible when leaders provide resources and act consistently on safety information.

Continuous learning, mentoring and evaluation can support personnel beyond initial certification. Technology adoption should be accompanied by workflow redesign, training and evaluation rather than treated as an equipment purchase. Recognition and participation in decision-making can also strengthen professional standing. In Malaysia, Masrom et al. (2025) proposed a contractor-oriented framework incorporating training, technology, emergency preparedness and wider management measures. Their study demonstrates the value of combining individual interventions within a coordinated programme suited to project conditions. Taken together, the literature suggests that safety performance is produced through a connected arrangement of capability, authority, communication and organisational support.

Research Gap and Conceptual Orientation

Existing research provides substantial knowledge about safety performance and behaviour, but the operational position of safety personnel warrants more direct attention. Malaysian studies have identified factors affecting health and safety practices, differences in workers' safety knowledge and behaviour, and measures for improving safety on major infrastructure projects (Masrom et al., 2025; Oni et al., 2024; Saedi et al., 2023). However, these studies do not directly examine the challenges encountered by construction safety personnel together with the organisational interventions intended to strengthen their role and the outcomes expected from improved role performance.

This study addresses that applied gap by ranking the three principal domains and organising them within a conceptual framework comprising challenges, pessimism, interventions and optimism. Challenges and pessimistic conditions represent role inhibitors, while interventions and optimistic conditions represent role stimulators. The framework provides an interpretive organisation of the descriptive results and a foundation for subsequent empirical assessment.

METHODOLOGY

Research Design and Setting

The study adopted a quantitative, cross-sectional survey design. Data were collected in 2023 from construction practitioners associated with organisations operating in Penang, Malaysia. The design was descriptive and exploratory because it sought to establish the relative importance assigned to predefined safety issues and interventions rather than to estimate causal effects. The unit of analysis was the individual respondent. Penang was selected as the geographical setting because it supports a substantial range of building, infrastructure and specialised construction activities involving contractors, consultants, regulatory personnel and safety practitioners. The setting provided an appropriate context for examining how construction safety responsibilities are undertaken within active project environments.

Participants and Sampling

A non-probability purposive approach was used to reach individuals with construction experience and safety-related knowledge or responsibilities. Invitations were disseminated electronically through participating organisations and professional networks. Fifty-four complete responses were retained for analysis. As the total number of individuals who received the invitation could not be determined, a conventional response rate was not calculated.

Participants included public officials, architects, quantity surveyors, project and design engineers, site supervisors, Safety and Health Officers, Site Safety Supervisors, project directors, owners and other construction practitioners. The sample is therefore described as construction practitioners with safety-related exposure rather than as a sample composed exclusively of registered safety professionals.

Purposive sampling was considered appropriate because the questionnaire required informed assessments of construction safety responsibilities, operational challenges and organisational interventions. Respondents were therefore selected based on their relevant professional exposure rather than through unrestricted public recruitment. The inclusion of participants from design, engineering, supervision, safety management and regulatory backgrounds allowed the study to examine the subject from several positions within the construction process. Consistent with its descriptive design, the study sought to establish patterns and priorities among knowledgeable practitioners rather than estimate population prevalence.

Questionnaire

The questionnaire contained six sections structured according to the research objectives. Sections A and B collected organisational and respondent information. Section C contained 10 items concerning current safety-compliance conditions. Section D measured 15 challenges faced by construction safety personnel. Section E contained 10 possible organisational interventions, while Section F measured 15 expected safety outcomes. Substantive items used a seven-point agreement scale from 1 (strongly disagree) to 7 (strongly agree). Section C provided contextual information on prevailing safety-compliance conditions, while the principal ranking analysis focused on Sections D, E and F in accordance with the study objectives.

Questionnaire development began with a targeted review of construction safety literature covering safety-management conditions, the responsibilities and constraints of safety personnel, organisational improvement measures and expected safety outcomes. Relevant issues were converted into questionnaire statements and arranged according to the study objectives. Preliminary scoping of construction safety practice informed the wording and practical coverage of the items. This approach ensured that each substantive section addressed a defined aspect of the research problem.

The instrument was designed primarily for exploratory ranking rather than confirmatory measurement. Internal consistency was assessed after data collection, while the interpretation of the findings was restricted

to the content represented by the administered items. Further instrument development may include independent content review, pilot testing and factor analysis to examine the dimensional structure of the constructs.

Data Analysis

Responses were analysed using IBM SPSS Statistics. Frequencies and percentages described the participants. Mean scores were used to rank items within each study domain, while standard deviations were reported to indicate response dispersion. When two or more items recorded identical mean scores, they were assigned the same rank using standard competition ranking. The subsequent rank was determined by the number of positions occupied by the tied items. Standard deviations were reported separately to indicate response dispersion but were not used to break ties in the mean-based rankings. Cronbach's alpha assessed internal consistency. Values above 0.70 were treated as acceptable for exploratory research. The coefficients were interpreted as indicators of consistency among responses to the administered items rather than as independent confirmation of construct validity. Coefficients above 0.90 were interpreted cautiously because exceptionally high values can occur when items measure very similar content. As no parametric inferential procedures were applied, the analysis focused on descriptive patterns and relative rankings.

Ethical Considerations

The study maintained voluntary participation, respondent anonymity and confidential treatment of the information provided. The questionnaire did not require respondents' names, and the findings are presented in aggregate form. The data were used solely for the stated research purposes.

RESULTS

Respondent Profile

Of the 54 respondents, 30 (55.6%) were men and 24 (44.4%) were women. The sample was comparatively young: 46 respondents (85.2%) were aged 20–29 years, six (11.1%) were aged 30–39 years and two (3.7%) were aged 40–49 years. Forty-three respondents (79.6%) held bachelor's degrees, while the remainder held diploma or postgraduate qualifications. Project engineers formed the largest occupational group (22%), followed by design engineers (18%), Safety and Health Officers (11%), public officials (11%) and site supervisors (9%).

Sixty-one per cent reported one to three years of high-rise construction experience and 24% reported three to five years. The profile provides relevant practitioner views but also indicates that the findings are weighted towards early-career personnel. This concentration should be considered when interpreting the priorities reported by the respondents.

Table 1. Selected Respondent Characteristics

Characteristic	Category	n	%
Gender	Male	30	55.6
	Female	24	44.4
Age	20–29 years	46	85.2
	30–39 years	6	11.1
	40–49 years	2	3.7
Education	Bachelor's degree	43	79.6
Experience	1–3 years	33	61.1
	3–5 years	13	24.1

Internal Consistency

All four domains recorded very high Cronbach's alpha coefficients, ranging from 0.981 to 0.992 (Table 2). These coefficients indicate strong internal consistency among responses to the items within each domain. Their exceptional magnitude may, however, suggest that some items address closely related aspects of the corresponding domain. The coefficients were therefore used to support the reliability of the descriptive analysis rather than to establish construct validity or dimensionality.

Table 2. Internal Consistency of the Study Domains

Domain	Items	Cronbach's alpha
Safety-compliance conditions	10	0.981
Challenges faced by safety personnel	15	0.989
Organisational interventions	10	0.992
Expected safety outcomes	15	0.992

Challenges Faced By Construction Safety Personnel

All 15 challenges recorded mean scores above the midpoint of the seven-point scale (Table 3), indicating that respondents generally regarded the assessed challenges as relevant to the work of construction safety personnel. Limited resources ranked first (mean = 5.20, SD = 1.709), followed by communication and language barriers (mean = 5.17, SD = 1.611).

Adapting to technological advancements and balancing safety with productivity were jointly ranked third, with both recording a mean of 5.15. The lower-ranked items remained relevant: even resistance from workers or subcontractors, ranked fifteenth, recorded a mean of 4.65.

Table 3. Ranking of Challenges Faced By Construction Safety Personnel

Rank	Challenge	Mean	SD
1	Limited resources	5.20	1.709
2	Communication and language barriers	5.17	1.611
3	Adapting to technological advancements	5.15	1.618
3	Balancing safety and productivity	5.15	1.720
5	Dealing with emergencies and crises	5.11	1.667
6	Managing multiple projects and sites	5.07	1.725
7	Resistance to change	5.04	1.659
8	Keeping up with changing regulations	5.02	1.710
9	Psychological factors	5.00	1.554
10	Limited influence on design and planning	4.98	1.654
11	High staff turnover	4.96	1.590
11	Worksite complexity and dynamics	4.96	1.566
11	Lack of authority or influence	4.96	1.625
14	Engaging and influencing stakeholders	4.93	1.576
15	Resistance from workers or subcontractors	4.65	1.604

Organisational Interventions

Clear roles and responsibilities and training and education were jointly ranked first, with both recording a mean of 5.56 (Table 4). Technology adoption ranked third (mean = 5.43), followed by leadership support (mean = 5.39) and continuous improvement and learning (mean = 5.37). The narrow range between the highest and lowest means indicates broad support for the full set of interventions. Recognition and incentives ranked tenth but still recorded a favourable mean of 5.26.

Table 4. Ranking of Organisational Interventions

Rank	Intervention	Mean	SD
1	Clear roles and responsibilities	5.56	1.525
1	Training and education	5.56	1.667
3	Technology adoption	5.43	1.487
4	Leadership support	5.39	1.535
5	Continuous improvement and learning	5.37	1.533
6	Mentorship and support	5.35	1.592
7	Evaluation and metrics	5.33	1.554
8	Collaboration and communication	5.31	1.623
9	Empowerment in decision-making	5.28	1.618
10	Recognition and incentives	5.26	1.639

Expected Safety Outcomes

Prevention of accidents, proactive hazard mitigation and control, and timely hazard identification and risk assessment were jointly ranked first, with each recording a mean of 5.70 (Table 5). Cost savings and productivity gains ranked fourth (mean = 5.69), indicating that respondents did not view safety and project performance as mutually exclusive.

Positive safety culture ranked fifteenth but remained positively rated (mean = 5.50). The results indicate that respondents expected stronger organisational support for safety personnel to contribute to improved preventive practices and broader organisational performance.

Table 5. Ranking of Expected Safety Outcomes

Rank	Expected outcome	Mean	SD
1	Prevention of accidents	5.70	1.525
1	Proactive hazard mitigation and control	5.70	1.382
1	Timely hazard identification and risk assessment	5.70	1.423
4	Cost savings and productivity gains	5.69	1.425
5	Positive reputation and stakeholder trust	5.67	1.467
6	Continuous improvement in safety performance	5.65	1.532
7	Effective safety training and communication	5.63	1.545
7	Compliance with safety standards	5.63	1.445
9	Effective safety documentation and record-keeping	5.61	1.510
9	Emergency response preparedness	5.61	1.547
9	Collaboration with regulatory agencies	5.61	1.450
12	Enhanced contractor and subcontractor engagement	5.59	1.421
13	Improved safety reporting and incident management	5.57	1.500
14	Increased worker confidence and morale	5.52	1.539
15	Positive safety culture	5.50	1.735

DISCUSSION

Resources as an Operational Condition

The highest ranking assigned to limited resources indicates that respondents viewed the effectiveness of safety personnel as an organisational capacity issue rather than solely as a matter of individual competence or diligence. Safety personnel require time to inspect work areas, follow up corrective actions, conduct inductions, maintain documentation and participate in planning. When staffing and time are insufficient, attention may be directed towards immediate or visible hazards while lower-profile risks receive less systematic review. This interpretation accords with recent research treating safety climate as the product of connected organisational, supervisory and worker-level conditions (Kima et al., 2026; Xia et al., 2023). It is also consistent with the Malaysian findings of Oni et al. (2024), who identified inadequate safety planning, management failure, poor supervision and enforcement, and insufficient experience among the important factors affecting construction health and safety practices. Although their study examined industry-level practices, its findings support the present emphasis on the organisational conditions surrounding safety work.

Resource sufficiency should therefore be evaluated in relation to workload and project complexity. A nominal appointment does not demonstrate that a project has adequate safety coverage. Organisations can translate this result into measurable provisions, including the ratio of safety personnel to active work fronts, time allocated to preventive inspections, corrective-action closure time, training hours and access to monitoring equipment. These measures would make management support observable and auditable. The prominence of resource limitations in the findings supports further project-level examination of how staffing, workload and technical provision affect the capacity of safety personnel to complete preventive and corrective duties.

Communication and Language

Communication and language barriers ranked second, reinforcing the practical challenge of transferring safety requirements through a diverse workforce and subcontracting structure. Recent safety-climate reviews identify communication as a recurrent mechanism through which management priorities and supervisory expectations reach workers (Xia et al., 2023). Saedi et al. (2023) found differences in workers' safety knowledge, attitudes and practices according to demographic characteristics and interaction with behaviour-based safety programmes at Malaysian construction sites. These findings suggest that communication strategies should account for differences in experience, education and behavioural responses within the workforce. Safety communication should therefore be assessed by comprehension rather than delivery alone. A signed attendance sheet confirms presence at a briefing but does not establish that workers understood the relevant hazard and control.

Practical responses include multilingual toolbox materials, pictorial work instructions, demonstrations, confirmation questions and the use of competent interpreters or bilingual supervisors. Safety personnel should also receive training in concise communication and verification of understanding. These measures support the high ranking given to training, collaboration and clear responsibilities in the intervention results.

Technology and Changing Work Requirements

Adapting to technological advancements ranked jointly third. Digital inspection and reporting systems may improve traceability and access to information, but their benefits depend on usability, infrastructure and user competence. If digital requirements are added without removing duplicate paper processes, technology may increase workload. Organisations should first define the decision or process that the technology is expected to support, then provide training, technical assistance and an implementation period. The ranking of technological adaptation as a challenge and technology adoption as the third-ranked intervention indicates a

dual concern. Respondents recognised the potential contribution of technology while also acknowledging the organisational and competency requirements associated with its implementation.

The result is compatible with technology-oriented research on immersive training, hazard recognition and personalised learning assessment (Choi et al., 2023; Han et al., 2022; Liao et al., 2025; Ozel & Pekerikli, 2025; Rokooei et al., 2023). Masrom et al. (2025) also incorporated technology-based measures into a broader safety improvement framework for Malaysian mass rapid transit projects. Their findings support the integration of technology with training, management responsibility and established safety processes. For many organisations, the immediate priority may be reliable mobile reporting, action tracking and access to current documents rather than complex automated systems. Technology selection should reflect project scale, risk and capability.

Authority, Leadership and Role Clarity

Clear roles and responsibilities received the highest intervention rating. This finding addresses uncertainty about who may issue instructions, stop work, assign corrective action and verify closure. Written responsibility matrices should identify decision rights and escalation paths, particularly where several contractors operate simultaneously. Role clarity must be reinforced by management behaviour; otherwise, formal authority may not translate into practice. The result complements the Malaysian findings of Oni et al. (2024), in which management failure and poor supervision and enforcement were identified as important safety-practice factors. Role definition and enforcement authority should therefore be considered together when strengthening the position of safety personnel.

Leadership support ranked fourth and should be understood as a condition affecting the other interventions. Leaders control budgets, work programmes, enforcement and access to decision forums. Their conduct also communicates which behaviours are tolerated.

Recent empirical studies link safety leadership with positive safety climate and worker safety behaviour, including the role of perceived employer obligations (Elosta & Alzubi, 2024; Sankar et al., 2024). Masrom et al. (2025) similarly placed contractor responsibility and coordinated management measures at the centre of safety improvement for complex Malaysian infrastructure projects. Safety personnel are more likely to influence practice when managers act on their recommendations and avoid rewarding production achieved through unsafe shortcuts.

Training, Learning and Professional Support

Training and education shared the highest mean with role clarity. Recent studies show that construction safety training is expanding beyond conventional instruction towards immersive, interactive and data-informed approaches (Choi et al., 2023; Han et al., 2022; Rokooei et al., 2023). Uddin et al. (2023) examined the emerging potential of generative artificial intelligence to support hazard-recognition learning and construction safety education. This finding aligns with previous research on immersive training, hazard recognition and personalised learning assessment. Liao et al. (2025) found that safety capacity and personalised training were relevant to workers' hazard-recognition performance.

Malaysian evidence also indicates that worker characteristics are associated with differences in safety knowledge, attitudes and practices (Saedi et al., 2023). Together, these studies support training that responds to differences in competence, experience and learning needs. Training should remain continuous and task-relevant rather than limited to compliance certificates. Priority topics include hazard recognition, investigation, emergency coordination, communication across languages, legal updates, digital tools and the interpersonal skills required to challenge unsafe decisions.

Mentoring and continuous learning can support early-career personnel, which is particularly relevant because most respondents in this study had limited industry experience. Structured mentoring can provide

access to site-specific knowledge that formal courses may not cover. Periodic review of safety decisions, near misses and corrective-action quality can convert project experience into organisational learning. This professional support may be especially relevant in settings where safety personnel are required to make decisions involving unfamiliar hazards, several subcontractors or rapidly changing work conditions.

Interpretation of Expected Outcomes

Respondents placed accident prevention, hazard mitigation and timely risk assessment at the top of the expected outcomes. These priorities reflect the preventive purpose of safety personnel. The similarly high rating for cost savings and productivity gains suggests that practitioners recognised operational benefits from preventing disruption, rework and incidents.

Masrom et al. (2025) similarly approached safety improvement in Malaysian infrastructure construction as a coordinated process involving contractor action, preventive measures and operational arrangements. This provides contextual support for connecting organisational interventions with expected safety and project benefits.

The outcome rankings should nevertheless be interpreted as expectations rather than measured effects. The cross-sectional design did not test whether the proposed interventions caused lower accident rates or higher productivity. The findings therefore identify the outcomes that practitioners associate with stronger role performance and provide a set of relationships for future project-based assessment.

Proposed Conceptual Framework for Strengthening Construction Safety Personnel

The proposed conceptual framework interprets the difficulty of realising the intended role of construction safety personnel as a role realisation conundrum. It organises the descriptive survey findings into four connected domains: challenges, pessimism, interventions and optimism. Challenges and pessimistic conditions are conceptualised as role inhibitors, while interventions and optimistic conditions are conceptualised as role stimulators. The framework provides an interpretive structure for organising the principal findings without assuming statistically established relationships among its components.

The challenge domain is derived from the five highest-ranked challenges. Resource constraints correspond to limited resources, while communication barriers correspond to communication and language differences. Technological awkwardness represents the challenge of adapting to technological advancements. Prioritisation quandaries reflect the need to balance safety and productivity, while crisis-management demands correspond to dealing with emergencies and crises. Their position in the framework reflects their relative importance within the descriptive rankings.

The pessimism domain represents adverse role conditions associated with unresolved challenges. Defiance corresponds conceptually to resistance from workers, subcontractors and other stakeholders. Ineffective communication reflects failure to achieve understanding despite the transmission of safety information. Safety compromise represents situations in which production requirements displace safety priorities. Ineffective supervision reflects weak implementation and follow-up, while role curtailment relates to limited authority or influence. These concepts consolidate related concerns represented within the broader set of survey items.

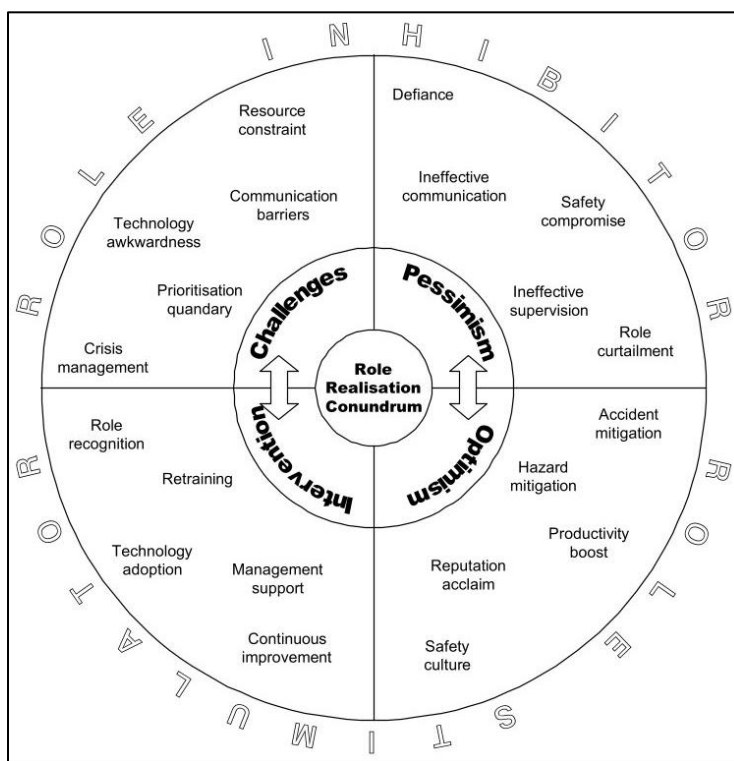
The intervention domain is constructed from the organisational measures supported by respondents. Role recognition incorporates clear responsibilities and empowerment in decision-making. Retraining represents training, education and continuing competency development. Technology adoption retains the corresponding survey intervention, while management support incorporates leadership, mentoring and organisational assistance. Continuous improvement includes organisational learning, evaluation and performance monitoring. The framework groups related interventions to provide a concise structure while retaining their empirical basis.

The optimism domain represents the expected results of improved role performance. Accident mitigation, hazard mitigation, productivity improvement, reputational benefits and safety culture correspond to the principal preventive, operational and organisational outcomes reported in Table 5. These elements indicate the outcomes that respondents associated with stronger support for construction safety personnel.

The two-way arrows surrounding the central conundrum indicate that role performance is dynamic. Role inhibitors may weaken the implementation of suitable interventions, while sustained organisational support may reduce adverse conditions and strengthen role performance.

The conceptual structure is broadly consistent with Malaysian research on factors affecting construction health and safety practices and coordinated contractor-led improvement measures (Masrom et al., 2025; Oni et al., 2024). The proposed conceptual relationships require further examination through expert assessment and project-based evaluation.

Figure 1. Proposed conceptual framework for the role realisation of construction safety personnel



Application of the Framework

Application begins by diagnosing the role inhibitors operating on a project. Interviews, inspections, workload records and safety-performance information can be used to determine whether resource constraints, communication problems, technological limitations, conflicting priorities or crisis demands are restricting the work of safety personnel. Management should then examine the related pessimistic conditions, including whether safety instructions are resisted, supervision is ineffective, safety is compromised for production, or the authority of the safety role has been curtailed.

Interventions should be selected in response to the diagnosed conditions rather than applied as a generic package. Role recognition and explicit authority can address curtailment and defiance; retraining can address competency and communication needs; suitable technology can improve hazard information and reporting; management support can protect safety priorities; and continuous improvement can sustain learning. These pairings provide practical directions for intervention selection, while allowing organisations to adapt individual measures to the conditions of each project.

Each intervention should have an accountable owner, allocated resources, a completion period and a measurable indicator. Outcome monitoring should then determine whether the intervention contributes to hazard and accident mitigation, productivity, organisational reputation or safety culture. Relevant indicators may include inspection coverage, corrective-action closure time, repeated non-conformities, near-miss reporting, participation in planning, verified completion of hazard controls and accident frequency.

The feedback relationship is central to the framework. Outcome information should be reviewed jointly by safety personnel and project leadership so that weak or ineffective measures can be revised. This cyclical application connects role recognition, organisational support and performance evaluation. Further research may assess the framework through expert evaluation, project implementation and longitudinal comparison of safety-performance indicators.

Practical Implications

Contractors should determine safety staffing and time requirements from project risk, work fronts and subcontractor complexity. Clients and project directors should include safety personnel in design, planning and programme decisions where their advice can prevent hazards before work begins. Site managers should document stop-work authority and corrective-action escalation. Safety briefings should use language and visual formats appropriate to the workforce and should include checks of understanding. Training plans should cover emerging technology, regulatory updates and communication skills. Finally, organisations should monitor leading indicators such as inspection coverage, corrective-action closure time, repeated non-conformities, near-miss reporting and participation in safety planning, rather than relying solely on injury totals. The framework can assist organisations in matching these measures to the operational conditions affecting safety personnel and in monitoring whether the selected responses produce the intended improvements.

LIMITATIONS AND FUTURE RESEARCH

This study should be interpreted within its methodological and contextual boundaries. The findings were derived from 54 construction practitioners selected through purposive sampling in Penang. This approach was suitable for obtaining informed assessments from respondents with relevant construction and safety-related experience. However, the sample size, geographical concentration and predominance of early-career respondents require caution when applying the findings to construction settings with different workforce, project or organisational characteristics. The study also relied on perceptions collected at a single point in time and did not examine changes in verified accident records, hazard-closure performance, productivity or other project indicators. Although the high Cronbach's alpha coefficients indicate strong internal consistency, their magnitude may reflect similarity among some questionnaire items. The proposed conceptual framework was developed from descriptive rankings and conceptual grouping. It should therefore be regarded as an exploratory interpretive structure rather than a validated causal or predictive model.

Future research should test these findings using larger and more diverse samples covering several Malaysian states, project types and organisational settings. Stratified sampling could provide stronger representation of Safety and Health Officers, Site Safety Supervisors, workers, contractors, consultants, clients, project managers and regulatory personnel. Further development of the questionnaire should include expert content assessment, pilot testing, item analysis and exploratory or confirmatory factor analysis to evaluate item distinctiveness and construct structure. The proposed conceptual framework should also be evaluated through expert consensus, project-based applications and longitudinal studies examining whether improvements in resources, communication, authority, training, technology adoption and management support correspond with measurable changes in corrective-action closure time, repeated non-conformities, near-miss reporting, safety climate, productivity and accident performance.

CONCLUSION

This study examined the challenges affecting construction safety personnel and the organisational interventions considered necessary to strengthen their role. Among the 54 surveyed practitioners, limited resources, communication and language barriers, adaptation to technological advancements, and balancing safety with productivity received the highest challenge rankings. Clear roles and responsibilities, training and education, technology adoption and leadership support were the most strongly supported interventions. Respondents expected improved support for safety personnel to contribute principally to accident prevention, proactive hazard control and timely risk assessment.

The findings suggest that respondents viewed organisational conditions as important influences on the effectiveness of safety personnel. Technical appointment and formal compliance may be insufficient when personnel lack time, resources, authority or access to decision-making processes. Recent Malaysian research on health and safety practices, worker safety knowledge and contractor-led safety improvement supports this organisational interpretation (Masrom et al., 2025; Oni et al., 2024; Saedi et al., 2023).

The proposed conceptual framework organises common constraints, practical interventions and intended outcomes into a structured basis for organisational review. The proposed relationships remain exploratory and require further evaluation through broader surveys, expert assessment and project-based implementation. Within its defined context, the study contributes an integrated assessment of the challenges, interventions and outcomes associated with construction safety personnel. It also provides a structured basis for organisations seeking to strengthen the personnel responsible for translating safety requirements into everyday construction practice.

Acknowledgements

The authors thank the construction practitioners and organisations that supported the questionnaire survey.

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