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Evaluating the Impact of Critical Success Factors of Incident Prevention Programs on Construction Project Success

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ABSTRACT

Construction projects operate in inherently high-risk environments where workplace incidents can significantly impact both worker's safety and Overall Project Success (OPS). Although various safety initiatives have been implemented, inconsistent application and constrained safety budgets often hinder the realization of zero-accident objectives. This study aims to identify the Critical Success Factors (CSFs) of incident prevention programs in the construction industry. Drawing from 15 safety management process criteria outlined in the International Sustainability Rating System (ISRS), a structured questionnaire was distributed to 109 safety practitioners and managers involved in Indonesian construction projects. Using Partial Least Squares Structural Equation Modelling (PLS-SEM), the study examined the influence of safety program implementation on incident prevention success and its subsequent impact on OPS. The analysis identified five key CSFs—risk evaluation, communication and promotion, leadership, contractor and supplier management, and training and competence—that CSFs significantly enhance incident prevention outcomes. These factors were statistically proven to contribute 82.7% to the success of incident prevention programs and 35.1% to OPS. The findings enrich existing safety management literature and offer practical guidance for designing targeted safety programs, particularly in environments with limited resources. Prioritizing these CSFs can lead to improved safety performance and more successful project delivery.

1. INTRODUCTION

Occupational safety is a managerial function that must be rigorously managed alongside the project triple constraint of quality, cost, and time. In the construction project environment, which is characterized by inherently high levels of risk, workplace safety represents a critical concern, as approximately 30%–40% of all fatal incidents worldwide occur within the construction sector [1, 2]. In Indonesia, statistical records for 2024 indicate that 4,233 workplace incidents were reported in the construction industry, including several fatal cases, underscoring the persistent severity of safety challenges [3]. Factors such as unsafe conditions, limited hazard awareness, weak safety culture, and inadequate implementation of safety management systems significantly contribute to the occurrence of construction accidents [4-8]. These incidents not only cause direct harm to workers but also pose substantial risks to Overall Project Success, leading to cost overruns, schedule delays, reduced productivity, and reputational damage [9, 10]. Furthermore, the dynamic nature of construction projects, their complex workflows, and the involvement of multiple stakeholders (including contractors, subcontractors, and suppliers) further intensify the likelihood of workplace incidents [11].

From a safety management theory perspective, effective incident prevention programs aim to control unsafe actions and unsafe conditions through systematic planning, continuous safety training, strong safety leadership, effective supervision, and continuous monitoring [12-14]. Well-implemented safety programs have been shown to reduce both the frequency and severity of workplace incidents, thereby minimizing injuries, equipment damage, work stoppages, and rework, and ultimately supporting stable and uninterrupted construction operations [9]. In line with project management theory, safety performance is closely associated with traditional project success criteria, including cost efficiency, schedule performance, labor productivity, and organizational reputation [9, 10]. Accordingly, the CSFs of incident prevention programs—such as management commitment, safety leadership, worker participation, effective communication, and continuous safety training—play a pivotal role in enhancing control over project resources and execution processes, contributing both directly and indirectly to OPS [13, 15, 16].

In addition, organizational behavior theory emphasizes the influence of leadership, safety culture, and team dynamics on individual and collective behaviors within construction settings [17]. Improvements in safety-related behaviors enhance teamwork, reduce conflict, and strengthen coordination on construction sites, which are essential for achieving project objectives in complex and high-risk environments [18].

Although various measures, including the adoption of safety standards, regulatory enforcement, and intensified supervision, have been introduced to reduce accident rates, inconsistent implementation of safety protocols, budgetary constraints, and the absence of a comprehensive and integrated safety approach remain significant barriers to achieving zero-accident targets [19, 20].

In this context, the International Sustainability Rating System (ISRS) provides a globally recognized framework for evaluating and improving occupational health and safety management through fifteen proactive management processes focused on incident prevention [21]. Nevertheless, empirical studies that systematically identify ISRS-based CSFs influencing the effective implementation of incident prevention programs in construction projects remain limited.

Therefore, adopting a systematic and data-driven approach to identify these key factors is essential. Based on an integrated theoretical framework encompassing safety management, project management, and organizational behavior theories, this study proposes that the CSFs of incident prevention programs exert a significant positive effect on OPS [9, 10, 12, 17]. These hypothesized relationships are empirically examined using Partial Least Squares Structural Equation Modeling (PLS-SEM) to capture both direct and indirect causal effects among latent constructs.

2. RESEARCH METHOD

A construct elimination method was adopted in this research, as outlined in the research framework (Figure 1). Fifteen research variables were initially identified based on the ISRS standard (Table 1). Subsequently, a structured questionnaire was administered to experienced safety professionals in the construction sector to assess the importance and relevance of each variable in the implementation of safety programs.

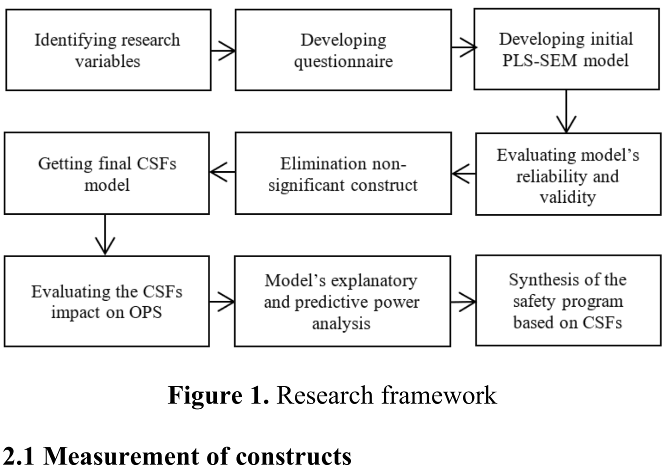

Figure 1. Research framework

2.1 Measurement of constructs

This study employed a structured questionnaire to measure the latent constructs of the CSFs of incident prevention programs and OPS. The measurement items were developed through a comprehensive review of the literature in safety management and construction project management to ensure a strong theoretical foundation and content validity. Subsequently, the items were contextualized using construction industry terminology to facilitate respondent's understanding and to enhance their clarity and relevance.

2.1.1 Measurement of critical success factors of incident prevention programs

The CSFs of incident prevention programs are conceptualized as a multidimensional construct encompassing several key dimensions explicitly specified in the ISRS framework and prior studies, including leadership, training and competency, communication and promotion, risk evaluation, planning and administration, asset management, project management, human resources, compliance assurance, riks control, contractor and supplier management, emergency preparedness, learning from incident, risk monitoring and review of the results [21]. Each dimension is measured using multiple indicators to comprehensively represent the underlying construct. Respondents were asked to indicate their level of safety program implementation and the overall project conditions at their workplace for each statement using a Likert-scale response format.

2.1.2 Measurement of Overall Project Success

OPS was defined as a multidimensional construct encompassing both conventional and non-conventional criteria of project success. The measurement indicators captured project performance related to cost efficiency, adherence to schedules, workers productivity, and company reputation [9, 10]. This conceptualization aligns with widely recognized project management frameworks and enables a comprehensive evaluation of project outcomes within the construction industry.

2.2 Data collection

To gather quantitative data for the study, a primary survey was carried out by distributing questionnaires to Indonesian construction practitioners. The survey was divided into four main sections: the respondent's demographic profile (including project profile), the implementation of safety program, recorded incidents and the overall condition of the project (Table 1 and Table 2). Utilizing a 5-point Likert scale, ranging 1 (poor safety program implementation) to 5 (excellent safety program implementation). Respondent were asked to complete the questionnaire based on their project's safety implementation. A total of 109 valid data entries were obtained for analysis. Yin [22] and Rahadi [23] found that a sample size of over 100 is recommended for PLS-SEM analysis, therefore, the number of responses in this study was deemed acceptable.

This study was conducted within the construction industry in Indonesia, encompassing diverse project types, including oil gas and smelting construction, building and real estate construction, transportation infrastructure construction, industrial and power plant construction, offshore facilities construction, water infrastructure construction, and maintenance construction. The data were collected from small, medium, and large-scale projects (classified according to the project contract value) to reflect industry heterogeneity. Respondents comprised construction professionals directly involved in project execution and safety management, such as project managers, safety manager, safety personels and supervisors, all of whom possessed relevant experience in incident prevention practices.

Table 1. Critical success factors variables and measurement indicators

Variable	Codes	Description
Leadership [L]	L1	OHS plan approved by management.
	L2	Direct involvement of management in OHS programs.
Training and Competency [TC]	TC1	OHS training procedures.
	TC2	Relevance of training types to the job.
	TC3	Implementation of worker induction programs.
Communication and Promotion [CP]	CP1	Conducting OHS meetings.
	CP2	Conducting safety talks before work.
	CP3	"Lesson learned" programs.
Risk Evaluation [RE]	RE1	Identification of job-related risks.
	RE2	Conducting Job Safety Analysis (JSA).
Planning and Administration [PA]	PA1	Job planning involves OHS personnel.
	PA2	Document archiving.
Asset Management [AM]	AM1	Initial inspection of equipment.
	AM2	Development of an equipment register.
Project Management [PM]	PM1	Conducting regular meetings.
	PM2	Conducting project planning.
	PM3	Development of a risk register.
Human Resources [HR]	HR1	OHS within the organizational structure.
	HR2	Determination of job descriptions for personnel.
	HR3	Human resource management procedures.
	HR4	Performance evaluation programs.
	HR5	Management of change procedure.
Compliance Assurance [CA]	CA1	Identification of relevant regulations.
	CA2	Health and occupational accident insurance programs.
Risk Control [RC]	RC1	Use of personal protective equipment (PPE).
	RC2	Implementation of the permit-to-work system.
	RC3	Implementation of signage systems.
Contractor & Supplier Management [CSM]	CSM1	Development of subcontractor qualification procedures.
	CSM2	Subcontractor evaluations.
Emergency Preparedness [EP]	EP1	Establishment of emergency response teams.
	EP2	Provision of emergency facilities.
	EP3	Conducting emergency training.
Learning from Incidents [LI]	LI1	Hazard reporting procedures.
	LI2	Accident investigation implementation.
	LI3	Follow-up on accident investigations.
Risk Monitoring [RM]	RM1	Environmental monitoring.
	RM2	OHS audit programs.
Results and Review [RR]	RR1	Management review programs.

Table 2. Incident prevention success and OPS variables and measurement indicators

Variable	Codes	Description
Success of Incident Prevention [SUCC]	LTI	Number of work accidents resulting in lost workdays
	FAT	Number of work accidents resulting in fatalities
Overall Project Success [OPS]	COST	Project budget compliance with the contract
	TIME	Project duration compliance with the contract
	PROD	Work productivity compliance with the S-curve planning
	REPU	Project reputation among workers and the surrounding community

In addition to utilizing the fifteen management processes from the ISRS, this study also incorporates number of loss time injury and fatality incident as variables to measure the success of workplace incident prevention on each construction project. Meanwhile, the OPS variable is defined to include project completion time, the project's profit and loss condition, work productivity, and the project reputation (Table 2).

2.3 Model measurements and analysis testing

2.3.1 Model development

PLS-SEM has gained widespread use across many disciplines, particularly in business and social sciences [24, 25]. In this study, PLS-SEM was used to analyze data related to incident prevention program due to its strong predictive capabilities [26]. This method is especially useful for building causal models and is well-suited for research involving smaller sample sizes and the need to explain the variance in key outcome variables [27].

2.3.2 Evaluation of measurement models

Internal consistency validity, convergent validity, discriminant validity and variance inflation factor (VIF) was used as criteria to ensure the validity of the model in this study. Internal consistency reliability refers to the degree to which indicators that measure the same construct are consistently related to one another. In case PLS-SEM is used for the model, the outer loading, cronbach's alpha (α), composite reliability (ρ_c) may be used to assess the internal consistency reliability of the measured constructs [9, 28]. A value of $\alpha \geq 0.7$; $\rho_c \geq 0.7$ was proposed as the threshold.

Convergent validity indicates the extent to which a construct effectively accounts for the variance in its associated indicators by showing that they are strongly correlated [28].

Average variance extracted a value greater than $AVE \geq 0.5$ is recommended [28]. The final step is to evaluate discriminant validity. This metric assesses how clearly a construct can be distinguished from other constructs within the structural model [28]. To establish discriminant validity, the similarities between different measures should not be excessively high [29]. Heterotrait-monotrait ratio (HTMT) was recommended as better alternative to asses discriminant validity [28]. A value of HTMT < 0.9 is recommended as threshold [27].

2.3.3 Evaluation of structural models

The VIF must also be considered during the analysis process. A VIF value below 5 is generally acceptable, as higher values indicate a greater degree of collinearity, which arises when two or more indicators within a formative measurement model are highly correlated [28]. To determine the significance level of a variable, an evaluation of the path coefficient and the model's significance (p-value) must be conducted. Path coefficient values range between -1 and +1, the closer the value is to +1, the stronger the positive effect, whereas values approaching -1 indicate a stronger negative effect [28]. This study adopts a 95% confidence interval criterion, whereby a variable is considered statistically significant if the p-value is equal to or less than 0.05.

2.3.4 Model's explanatory and predictive power

Coefficient of determination (R^2) indicates the model's ability to explain the variation in the data. (R^2) typically ranges from 0 to 1. Higher values mean better performance [28]. Meanwhile, the model's predictive power indicates its ability to make future predictions. A PLS-SEM Root Mean Square Error (PLS-SEM RMSE) and PLS-SEM Mean Absolute Error (PLS-SEM MAE) that is smaller than the linear regression benchmark (LM) indicates that the model has high predictive power [28].

3. RESULTS

3.1 Respondent characteristics

Figure 2 presents the demographic profile of the respondents, including education level, work experience, organizational role, project value or project scale, and type of construction project. Figure 2(a) shows that the majority of respondents hold a bachelor's degree, indicating that they possess adequate cognitive and affective competencies to serve as reliable respondents [30]. Figures 2(b) and (c) jointly illustrate the respondents' experience and role positions within construction projects. Most respondents have more than three years of experience and occupy positions ranging from safety officer and safety inspector to safety manager, suggesting that they have a sound understanding of safety program implementation, occupational accident prevention planning, and the overall conditions of construction projects.

Figure 2(d) depicts the project value or project scale. The project contract value represents the capacity for and appropriateness of safety budget allocation in the projects used as case studies in this research. Accordingly, questionnaire responses were limited to projects with a contract value equal to or greater than IDR 100 billion. This restriction is associated with the influence of project contract value on the safety budget and project duration, both of which affect the implementation of safety programs within construction projects [31-33]. As a consequence of this criterion, the data obtained in this study exhibit a high level of homogeneity. Figure 2(e) shows the types of construction projects included as case studies, with the majority comprising oil and gas projects, industrial and power plant construction, and building and real estate projects. In addition, the study also covers other types of construction, such as offshore facilities, water infrastructure, transportation infrastructure, and maintenance construction.

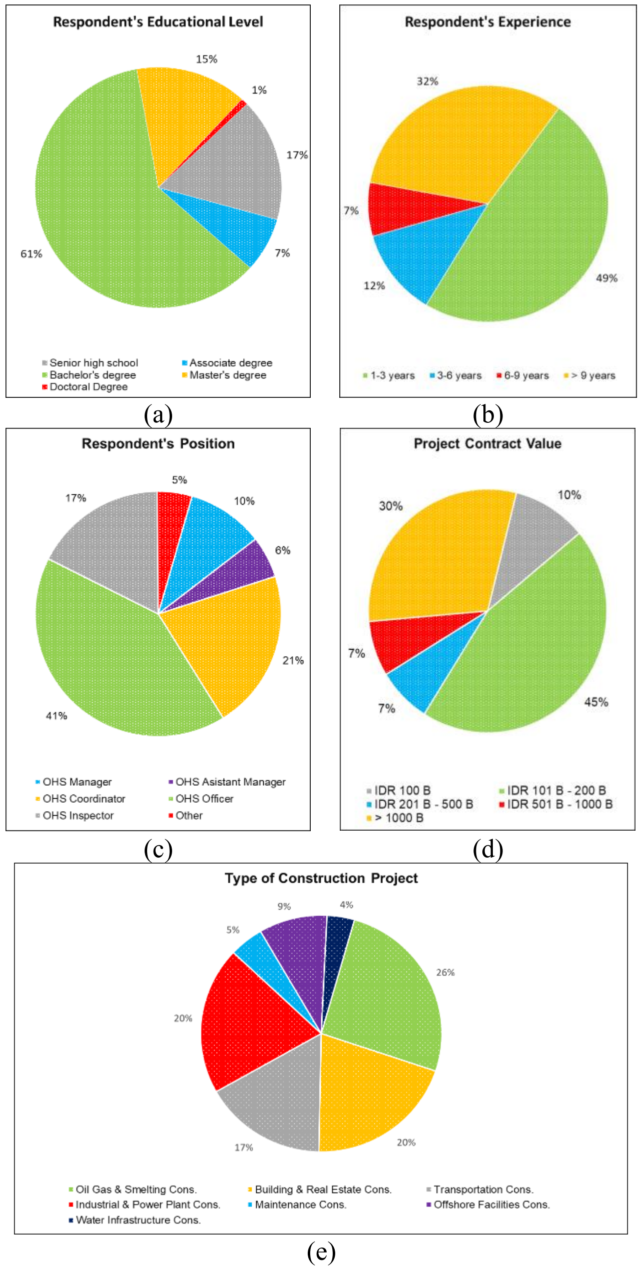

Figure 2. Respondent characteristics: (a) Educational level, (b) Experience, (c) Position, (d) Project contract value, (e) Construction type

3.2 Measurement models

In the PLS-SEM analysis, an active modeling approach is applied to identify and define the nature of the relationships between the exogenous variables and their respective latent constructs, as outlined in Hair et al. [28]. During this phase of the analysis, the model undergoes a thorough evaluation that encompasses the assessment of internal reliability, convergent validity, discriminant validity and multicollinearity, all of which are essential to ensure the measurement model's robustness and accuracy. As presented in Table 3, all evaluated parameters successfully fulfill the minimum criteria required, outer loading ≥ 0.7, α ≥ 0.7, ρ_c ≥ 0.7, AVE ≥ 0.5 and VIF < 5, indicating that the measurement model satisfies the necessary thresholds for further analysis.

Table 3. Measurement model results

Construct	Item	Outer Loading	VIF	α	ρ_c	AVE
Leadership [L]	L1	0.857	2.469	0.920	0.940	0.757
	L2	0.837	2.469			
Planning and Administration [PA]	PA1	0.834	1.608	0.860	0.911	0.773
	PA2	0.896	1.000			
Risk Evaluation [RE]	RE1	0.918	2.183	0.897	0.936	0.829
	RE2	0.892	2.183			
Training and Competency [TC]	TC1	0.778	2.242	0.914	0.933	0.701
	TC2	0.800	1.707			
	TC3	0.799	2.232			
Project Management [PM]	PM1	0.915	2.802	0.902	0.939	0.836
	PM2	0.916	3.144			
	PM3	0.912	2.701			
Human Resources [HR]	HR1	0.860	2.644	0.924	0.943	0.769
	HR2	0.900	3.202			
	HR3	0.933	3.483			
	HR4	0.934	3.482			
	HR5	0.774	1.903			
Compliance Assurance [CA]	CA1	0.761	2.326	0.890	0.919	0.695
	CA2	0.871	2.326			
Communi-cation and Promotion [CP]	CP1	0.877	2.998	0.921	0.941	0.760
	CP2	0.883	2.444			
	CP3	0.850	2.547			
Risk Control [RC]	RC1	0.916	2.822	0.939	0.956	0.845
	RC2	0.923	4.122			
	RC3	0.916	3.927			
Asset Management [AM]	AM1	0.903	2.395	0.959	0.968	0.858
	AM2	0.906	2.395			
Contractor & Supplier Management [CSM]	CSM1	0.950	2.706	0.885	0.946	0.897
	CSM2	0.944	2.706			
Emergency Preparedness [EP]	EP1	0.876	2.569	0.938	0.952	0.798
	EP2	0.854	2.873			
	EP3	0.858	2.751			
Learning from Incidents [LI]	LI1	0.946	3.518	0.923	0.946	0.813
	LI2	0.893	2.736			
	LI3	0.845	2.203			
Risk Monitoring [RM]	RM1	0.826	1.892	0.878	0.916	0.732
	RM2	0.873	1.892			
Results and Review [RR]	RR1	1.000	1.000	*	*	*
Success of Incident Prevention (SUCC)	LTI	0.941	2.337	0.861	0.935	0.878
	FAT	0.933	2.337			
Overall Project Success [OPS]	COST	0.808	2.209	0.798	0.868	0.623
	TIME	0.810	2.027			
	PROD	0.831	1.674			
	REPU	0.700	1.278			

Notes: (*) Undefined due to the presence of only one item.

The subsequent result from the measurement model is discriminant validity, which demonstrates that a construct is unique and able to capture phenomena which are not reflected by other constructs within the model. This study evaluated discriminant validity using the HTMT criterion. Table 4 shows that all parameters of HTMT meet the criteria, as the HTMT values for all constructs are below 0.90.

3.3 Evaluation of structural models

The purpose of this study is to determine the CSFs from the 15 management process criteria provided by the ISRS and to determine their contribution to OPS. Based on the bootstrapping results using the PLS-SEM algorithm, it was found that not all variables or constructs met the required threshold. Table 5 shows that construct with *p*-value higher than 5% or negative path coefficient were eliminated from the model. For several constructs, the bootstrap analysis indicates negative path coefficients. These findings are noteworthy and warrant further investigation regarding the negative effects on the success of occupational accident prevention. However, as the primary focus of this study is to identify CSFs, constructs exhibiting negative effects were excluded from the model.

3.4 The CSFs of incident prevention program

Following the elimination of non-significant variables and negative path coefficient, the analysis revealed five variables that have a statistically significant and positive impact on the success of incident prevention program in construction projects (Figure 3). These variables include: Risk Evaluation [RE] (p-value = 0.000; path coefficient = 0.274), Communication and Promotion [CP] (p-value = 0.003; path coefficient = 0.241), Leadership [L] (p-value = 0.005; path coefficient = 0.204), Contractor and Supplier Management [CSM] (p-value = 0.012; path coefficient = 0.210), Training and Competency [TC] (p-value = 0.035; path coefficient = 0.153). Thus, it can be stated that the five variables are CSFs in this research model.

Table 4. Discriminant validity (HTMT) results

	LI	ER	RR	CA	L	CP	AM	CSM	PM	PA	TC	RC	RM	EP	HR	SUCC	OPS
LI																	
ER	0.710																
RR	0.835	0.571															
CA	0.734	0.525	0.708														
L	0.386	0.625	0.257	0.324													
CP	0.351	0.667	0.268	0.240	0.828												
AM	0.573	0.765	0.458	0.520	0.654	0.649											
CSM	0.671	0.832	0.597	0.652	0.632	0.701	0.757										
PM	0.827	0.524	0.678	0.806	0.335	0.268	0.527	0.653									
PA	0.591	0.613	0.548	0.576	0.440	0.420	0.664	0.673	0.526								
TC	0.484	0.659	0.346	0.342	0.774	0.839	0.652	0.729	0.378	0.463							
RC	0.633	0.849	0.495	0.501	0.720	0.821	0.788	0.822	0.436	0.588	0.770						
RM	0.794	0.528	0.712	0.648	0.203	0.314	0.418	0.632	0.652	0.458	0.307	0.424					
EP	0.867	0.520	0.775	0.661	0.306	0.293	0.554	0.613	0.782	0.624	0.385	0.471	0.874				
HR	0.890	0.679	0.805	0.806	0.357	0.363	0.678	0.714	0.896	0.691	0.449	0.549	0.782	0.843			
SUCC	0.450	0.885	0.326	0.273	0.860	0.899	0.708	0.876	0.309	0.526	0.881	0.891	0.309	0.319	0.382		
OPS	0.141	0.528	0.108	0.143	0.575	0.587	0.481	0.522	0.182	0.223	0.551	0.530	0.104	0.117	0.234	0.691	

3.5 Model's explanatory and predictive power

After the CSFs have been identified, the R^2 value needs to be analyzed to determine their contribution to the success of incident prevention. Table 6 shows that the five CSFs contribute 82.7% to the success of incident prevention and contribute 35.1% to the OPS. Meanwhile, Table 7 indicates that the PLS RMSE value is lower than the LM RMSE, and a similar finding is observed for the PLS MAE, which is also lower than the LM MAE. This suggests that the model has high predictive power in assessing its influence on the success of workplace accident prevention and OPS.

Table 5. Bootstrapping results

Construct	Path Coefficient	T-Statistics	*p*-value
L => SUCC	0.204	2.780	0.005
PA => SUCC	0.054	0.861	0.389*
RE =>SUCC	0.274	3.486	0.000
TC => SUCC	0.153	2.108	0.035
PM => SUCC	-0.010*	0.085	0.932*
HR => SUCC	-0.191*	1.535	0.125*
CA => SUCC	-0.163*	2.000	0.046
CP => SUCC	0.241	2.990	0.003
RC => SUCC	-0.004*	0.494	0.956*
CSM => SUCC	0.210	2.519	0.012
EP => SUCC	-0.041*	0.503	0.615*
LI => SUCC	0.021	0.186	0.852*
RM => SUCC	0.115	0.056	0.364*
RR => SUCC	-0.006*	0.090	0.944*
AM => SUCC	-0.017*	0.090	0.847*
SUC => OPS	0.593	9.197	0.000

Notes: (*) Eliminated from the model as its negative path coefficient and/or p-value is higher than 5%.

Table 6. Model's explanatory power

Construct	R^2 Original Sample (O)	R^2 Sample Mean (M)	Standard Deviation (STDEV)	T-Statistics (O/STDEV)
SUCC	0.827	0.834	0.043	19.189
OPS	0.351	0.364	0.077	4.543

Table 7. Model's predictive power

Item	PLS-SEM (RMSE)	PLS-SEM (MAE)	LM (RMSE)	LM (MAE)
FAT	0.366	0.262	0.386	0.279
LTI	0.478	0.341	0.486	0.356
COST	1.118	0.828	1.229	0.936
PROD	0.912	0.728	0.952	0.745
REPU	0.876	0.729	0.977	0.811
TIME	0.988	0.735	1.075	0.809

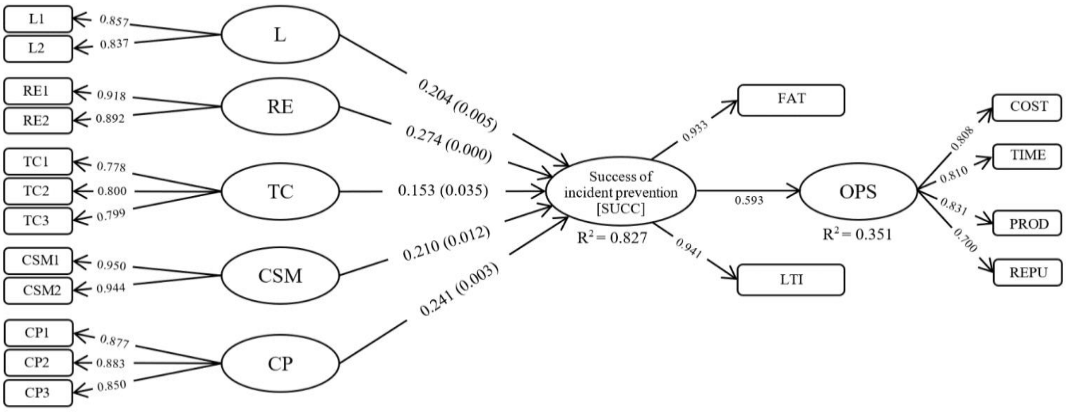

Figure 3. Final CSFs structural model

4. DISCUSSION

Workplace accidents in construction projects remain a significant issue due to the high-risk nature of the work. Priyono and Harianto [4] emphasize that factors such as workplace conditions and workers' awareness of hazards are key elements contributing to the occurrence of accidents. The 2,344 workplace accidents that occurred in construction projects across Indonesia during 2024 serve as strong evidence of this pressing issue. This problem is further exacerbated by the tendency of construction project management to be reluctant in allocating additional budgets for implementing accident prevention programs.

Based on theoretical perspectives, the causal mechanism underlying this study can be described as follows: CSFs of incident prevention programs enhance safety-related behaviors and safety performance, which lead to reduce incidents and operational disruptions, thereby improving productivity, schedule adherence, cost efficiency, and company reputation, ultimately contributing to OPS.

Therefore, this study aims to identify CSFs that significantly influence the prevention of workplace accidents, ultimately providing a potential solution to the issue of limited safety budgets in construction projects.

Based on the analysis using the PLS-SEM method, this study found that five safety programs have a significant impact, contributing 82.7% to the success of accident prevention efforts. These five safety programs are also found to contribute 35.1% to OPS. The following are five CSFs that will be discussed and may serve as recommendations for operational management.

4.1 Risk evaluation

Risk evaluation is defined as the process of identifying and recognizing health, safety, security, and environmental risks, requiring workers to maintain high awareness at all times [21]. Based on Table 4 and Figure 3, the contributing items to Risk Evaluation (RE) are RE1 and RE2, highlighting the need to identify and assess health, safety, environmental, and job-related hazards.

Hazard Identification, Risk Assessment, and Determining Control (HIRADC) is a structured program for identifying related hazards, typically documented with job types and associated risk parameters [34]. HIRADC is a core component of a safety management system and is effective in identifying significant risks to enable targeted mitigation [35, 36]. Similarly, Job Safety Analysis (JSA) outlines job steps, risks, and mitigation measures. It plays a crucial role in preventing accidents and losses in the workplace [37-39].

4.2 Communication and promotion

Effective communication is essential for delivering information and motivating workers. Various communication media, such as management meetings, should be utilized to discuss occupational health and safety (OHS) aspects [21]. Based on Table 4 and Figure 3, items CP1, CP2, and CP3 contribute to Communication and Promotion (CP), where OHS communication and promotion should be carried out through multiple channels, including routine safety meetings with management, toolbox talks, and safety stand-down programs.

Research by Xiaoyong et al. [40], Kim et al. [41], Bin Khairudin et al. [42] and Rice et al. [43] indicated that construction projects with well-conducted safety meetings tend to achieve better safety performance. In addition to safety meetings, OHS communication can be reinforced through toolbox talks, where supervisors brief their teams on work plans and relevant safety aspects. Studies by Rice et al. [43], Olson et al. [44], Jeschke et al. [45] and Eggerth et al. [46] highlighted that well-planned toolbox talks significantly enhance workers' awareness and safety behavior. Another effective method is the safety stand-down (SSD), where incidents from other sites are shared as learning material. According to Hallowell [47] and Drupsteen and Guldenmund [48], such "learning from incidents" programs can improve preventive actions and enhance critical knowledge in addressing safety challenges.

4.3 Leadership

Leadership as the process of establishing an organization's vision, mission, and objectives, with leaders bearing responsibility for risk identification and demonstrating a commitment to continuous improvement. As shown in Table 4 and Figure 3, items L1 and L2 contribute to the Leadership (L) construct, indicating that project leaders must develop and approve OHS Manual Plans or OHS KPIs and implement safety programs involving management.

Wu et al. [49] found that effective leadership strategies positively influence the safety climate, which in turn improves safety performance. Similarly, Mohammad [50] emphasized the role of KPIs in supporting time, cost, and safety outcomes in construction projects. These findings are reinforced by Schwatka et al. [51] and Ariyadi and Claudia [52], who concluded that Foundation for Safety Leadership (FSL) training enhances leaders' safety leadership capabilities. Lingard et al. [53] and Rani et al. [54] also demonstrated that direct involvement of top management improves safety performance. In construction projects, such engagement can be realized through management walkthrough (MWT) programs, where managers jointly visit work areas to observe and evaluate safety conditions.

4.4 Contractor and supplier management

In pursuit of efficiency, organizations are increasingly relying on contractors, outsourcing, and temporary workers. A key challenge is ensuring that contractors comply with the company's safety and environmental standards. Effective contractor management requires a proper selection process, clear definition of responsibilities, competency checks, adequate supervision, and thorough performance monitoring.

Based on Table 4 and Figure 3, items CSM1 and CSM2 contribute to the Contractor and Supplier Management (CSM) construct, indicating that in construction projects, contractor and supplier management should include contractor pre-qualification and performance evaluation. Research by Acheamfour et al. [55], Kukoyi et al. [56], and Alshamrani et al. [57] showed that contractor pre-qualification significantly influences project success and enhances safety performance when safety aspects are incorporated into the process. In addition to pre-qualification, contractor selection can also be based on performance evaluation. Studies by Alzahrani and Emsley [58] and Mahmoudi et al. [59] revealed that systematic contractor performance evaluations that include safety criteria have a significant positive impact on both project success and safety outcomes.

4.5 Training and competence

An effective training system is essential for identifying and delivering the necessary instruction to ensure individual competence. Similarly, a well-structured orientation or induction program is critical to prevent workers from facing risks at the start of their duties.

As indicated in Table 4 and Figure 3, items TC1, TC2, and TC3 contribute to the Training and Competence (TC) construct. In construction projects, safety training procedures must be established and implemented for all workers according to their roles, and induction programs should be conducted for new workers and visitors. Awais-E-Yazdan et al. [60] emphasized that delivering safety procedures through training is vital to maintaining a safe working environment. This is supported by Hussain et al. [61], Marquardt et al. [62], and Esfahani et al. [63], who found that safety training significantly improves workers' safety behavior. In addition to safety training, construction projects must conduct safety inductions for new workers and visitors. Safety induction introduces individuals to the worksite and its potential hazards, helping them become familiar with the environment [64]. Studies by Harvey et al. [64], Teck et al. [65] and Zakaria et al. [66] concluded that induction programs enhance new workers' understanding of workplace conditions.

5. CONCLUSIONS

Incident prevention programs have been extensively adopted in many construction projects as a means to reduce workplace incidents and fatalities. In Indonesia, the effective implementation of these programs is often hindered by the lack of a comprehensive, data-driven approach and limited budget allocation. Identifying the CSFs for incident prevention programs is considered a key step in addressing these issues. This study utilizes 109 valid data gathered from experienced safety practitioners involved in Indonesian construction projects. A PLS-SEM model, based on the 15 management processes outlined in ISRS, was developed and tested. The findings of this study provide empirical evidence that five CSFs significantly influence the success of incident prevention programs. The first factor is risk evaluation program, which includes identifying job-related risks and developing job safety analysis. The second factor is the communication and promotion program, which involves conducting meetings with stakeholders, pre-job safety talks, and communicating lessons learned from past incidents. The third factor is leadership program, which includes the development of the OHS manual plan with management approval and execution of OHS programs that actively engage management. The fourth factor is the contractor and supplier management program, which includes contractor pre-qualification and evaluating their safety performance. The final factor is the training and competency program, which includes, induction programs for new workers, developing standardized OHS training, and delivering job-specific training.

This study provides statistical evidence that the five identified CSFs contribute 82.7% to the success of incident prevention and 35.1% to OPS. Therefore, by implementing the five CSFs in a construction project, it can be stated that there is a 35.1% increase in the likelihood that the project will be on budget, on time, demonstrate high work productivity, and achieve a good reputation. These findings can be utilized by project management to design targeted safety programs, potentially leading to more efficient use of the project budget. Analysis results on the model's explanatory and predictive power further reinforce that the model developed in this study possesses high explanatory and predictive capabilities, indicating that it effectively represents actual conditions in construction projects.

Finally, there are several aspects of this study that could be improved. First, the analysis reveals that project management, human resources, compliance assurance, risk control, emergency preparedness, and asset management have negative path coefficients, indicating a potential negative impact on the success of incident prevention. Future studies are encouraged to explore and validate this finding. Second, future research should be conducted with a larger dataset, employs machine learning or deep learning methods to ensure more accurate and robust results. Although this study focuses on the direct effects of CSFs of incident prevention programs on OPS, it is acknowledged that this relationship may be mediated by safety performance and safety-related behaviors and moderated by contextual factors such as project scale and complexity. Future studies are encouraged to empirically test these mediating and moderating mechanisms to further enrich the understanding of incident prevention effectiveness in construction projects.

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REFERENCES

[1] Suartana, P., Mandagi, R.J.M., Wilar, D. (2021). The influence of occupational safety and health (OSH) knowledge on worker behavior and work accidents in projects at DS LNG, Banggai Regency, Central Sulawesi Province. Civil Engineering Journal on Research and Development, 2(1): 15-22. https://doi.org/10.22487/renstra.v2i1.234

[2] ILO. (2024). The leading source of labour statistics. https://ilostat.ilo.org/data/, accessed on Sep. 10, 2024.

[3] BPJS Ketenagakerjaan. (2025). Work Accident Statistics for the Year 2024. https://www.bpjsketenagakerjaan.go.id/laporan-terintegrasi.html, accessed on Feb. 16, 2025.

[4] Priyono, A.F., Harianto, F. (2020). Analysis of the implementation of the occupational health and safety management system (OHSMS) and the completeness of ohs facilities on building construction projects in Surabaya. Rekayasa: Jurnal Teknik Sipil, 4(2): 11. https://doi.org/10.53712/rjrs.v4i2.783

[5] Waqar, A., Andri, Qureshi, A.H., Almujibah, H.R., Tanjung, L.E., Utami, C. (2023). Evaluation of success factors of utilizing AI in digital transformation of health and safety management systems in modern construction projects. Ain Shams Engineering Journal, 14(11): 102551. https://doi.org/10.1016/j.asej.2023.102551

[6] Abas, N.H., Yusuf, N., Suhaini, N.A., Kariya, N., Mohammad, H., Hasmori, M.F. (2020). Factors affecting safety performance of construction projects: A literature review. In IOP Conference Series: Materials Science and Engineering, 713(1): 012036. https://doi.org/10.1088/1757-899X/713/1/012036

[7] Ranasinghe, U., Jefferies, M., Davis, P., Pillay, M. (2020). Resilience engineering indicators and safety management: A systematic review. Safety and Health at Work, 11(2): 127-135. https://doi.org/10.1016/j.shaw.2020.03.009

[8] Yang, W., Lu, Z. (2023). Analysis of key injury-causing factors of object strike incident in construction industry based on data mining method. Sustainability, 15(21): 15609. https://doi.org/10.3390/su152115609

[9] Buniya, M.K., Othman, I., Sunindijo, R.Y., Kashwani, G., Durdyev, S., Ismail, S., Antwi-Afari, M.F., Li, H. (2021). CSFs of safety program implementation in construction projects in Iraq. International Journal of Environmental Research and Public Health, 18(16): 8469. https://doi.org/10.3390/ijerph18168469

[10] Santo, J.S.C., Kusartomo, W. (2023). Solusi menurunkan angka kecelakaan kerja pada proyek konstruksi bertingkat. Jurnal Mitra Teknik Sipil, 6(2): 463-470. https://doi.org/10.24912/jmts.v6i2.23027

[11] Feng, D., Kang, Y. (2023). Methodology for risk assessment of engineering procurement construction project based on the probabilistic hesitant fuzzy multiple attributes group decision making. Journal of Intelligent & Fuzzy Systems, 45(6): 12255-12266. https://doi.org/10.3233/JIFS-231726

[12] Yiu, N.S.N., Chan, D.W.M., Shan, M., Sze, N.N. (2019). Implementation of safety management system in managing construction projects: Benefits and obstacles. Safety Science, 117: 23-32. https://doi.org/10.1016/j.ssci.2019.03.027

[13] Siregar, W.R., Machfudiyanto, R.A., Prasetyo, B., Suraji, A. (2024). Enhancing safety culture among subcontractors to improve safety performance in the indonesian construction industry. International Journal of Safety and Security Engineering, 14(6): 1913-1919. https://doi.org/10.18280/ijsse.140625

[14] Kurniawan, K.L., Machfudiyanto, R.A. (2023). A resilience approach to improving safety performance in construction. International Journal of Safety and Security Engineering, 13(3): 445-455. https://doi.org/10.18280/ijsse.130307

[15] Cui, L., Mo, J. (2025). How does supportive leadership impact the safety behaviors of the new generation of construction workers? Behavioral Sciences, 15(2): 110. https://doi.org/10.3390/bs15020110

[16] Estudillo, B., Carretero-Gómez, J.M., Forteza, F.J. (2024). The impact of occupational accidents on economic performance: Evidence from the construction. Safety Science, 177: 106571. https://doi.org/10.1016/j.ssci.2024.106571

[17] Elosta, M., Alzubi, A. (2024). The Interplay between safety leadership and construction workers' safety behavior: Do perceived employer safety obligations matter? Buildings, 14(11): 3650. https://doi.org/10.3390/buildings14113650

[18] Al-Bayati, A.J. (2021). Impact of construction safety culture and construction safety climate on safety behavior and safety motivation. Safety, 7(2): 41. https://doi.org/10.3390/safety7020041

[19] Wu, X., Qian, Q., Zhang, M. (2024). Impact of supervisor leadership on construction worker safety behavior in China: The moderating role of social capital. Engineering, Construction and Architectural Management, 31(5): 1947-1972. https://doi.org/10.1108/ECAM-02-2022-0180

[20] Yilmaz, M., Yildiz, S., Zorlu, F. (2020). The importance of occupational health and safety (OHS) and OHS budgeting in terms of social sustainability in construction sector. Journal of Civil and Environmental Engineering, 10(4). https://doi.org/10.37421/jcde.2020.10.353

[21] DNV. (2019). ISRS 9TH Edition Best Practice Safety and Sustainability Management (9th ed.). Det Norske Veritas Ltd.

[22] Yin, R.K. (2014). Case study research design and methods (5th ed.). Canadian Journal of Program Evaluation, 30(1): 108-110. https://doi.org/10.3138/cjpe.30.1.108

[23] Rahadi, D.R. (2023). Pengantar Partial Least Squares Structural Equation Modeling (PLS-SEM). Lentara Ilmu Madani.

[24] Soltaninejad, M., Faraji, A., Noorzai, E. (2021). Recognizing the effective factors in managing fire incidents to reduce the collateral damages and casualties. Facilities, 39(13/14): 805-827. https://doi.org/10.1108/F-03-2020-0030

[25] Henseler, J., Hubona, G., Ray, P.A. (2016). Using PLS path modeling in new technology research: Updated

guidelines. Industrial Management & Data Systems, 116(1): 2-20. https://doi.org/10.1108/IMDS-09-2015-0382
[26] Mahmudah, I.S., Choiruddin, A., Sutikno, Fitriyanah, V. (2024). Analysis of traffic accident risk in Nganjuk using point process on a linear network with lasso regularization. In 2024 IEEE Asia-Pacific Conference on Geoscience, Electronics and Remote Sensing Technology (AGERS), Manado, Indonesia, pp. 164-170. https://doi.org/10.1109/agers65212.2024.10932933
[27] Kineber, A.F., Othman, I., Oke, A.E., Chileshe, N., Buniya, M.K. (2021). Impact of value management on building projects success: Structural equation modeling approach. Journal of Construction Engineering and Management, 147(4): 04021011. https://doi.org/10.1061/(ASCE)CO.1943-7862.0002026
[28] Hair, J.F., Hult, G.T.M., Ringle, C.M., Sarstedt, M., Danks, N.P., Ray, S. (2021). Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook. Springer International Publishing. https://doi.org/10.1007/978-3-030-80519-7
[29] Campbell, D.T., Fiske, D.W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. Psychological Bulletin, 56(2): 81-105. https://doi.org/10.1037/h0046016
[30] Zulkarnain, I., Sitepu, Y.S., Sutatminingsih, R., Rajagukguk, M. (2024). Student's digital literacy competence and its implications for the learning process. International Journal of Evaluation and Research in Education, 13(2): 997. https://doi.org/10.11591/ijere.v13i2.25767
[31] Mishra, A.K. (2018). A review on time and cost issues of infrastructure projects. Journal of Advanced Research in Construction and Urban Architecture, 3: 32-46. https://doi.org/10.24321/2456.9925.201807
[32] Al-Bayati, A.J., O'Barr, K., Suk, S., Albert, A., Chappell, J. (2020). Experience modification rate as a prequalification criterion for safety performance. Professional Safety, 65(7): 31-38. https://aeasseincludes.assp.org/professionalsafety/pastissues/065/07/F2AlBayati_0720.pdf.
[33] Maharjan, S., Mishra, A.K., Aithal, P.S. (2023). Association between delay, project size and low bid percentage. International Journal of Applied Engineering and Management Letters, 7(2): 216-231. Srinivas Publication. https://doi.org/10.5281/zenodo.8130776
[34] Rotinsulu, F.N., Dundu, A.K.T., Malingkas, G.Y., Mondoringin, M.R., Thambas, A.H. (2023). Risk potential analysis using hazard identication, risk assessment and determine control (HIRADC) and job safety analysis (JSA) methods. Asian Journal of Engineering, Social and Health, 2(10): 1133-1141. https://doi.org/10.46799/ajesh.v2i10.147
[35] Ihsan, T., Hamidi, S.A., Putri, F.A. (2020). Penilaian risiko dengan metode HIRADC pada pekerjaan konstruksi gedung kebudayaan sumatera barat. Jurnal Civronlit Unbari, 5(2): 67. https://doi.org/10.33087/civronlit.v5i2.67
[36] Haristama, I.S., Zacoeb, A., Susanti, L. (2023). Risk analysis of occupational hazards using HIRADC approach in the implementation of occupational safety and health management system. Journal of Engineering Research and Reports, 25(6): 28-39. https://doi.org/10.9734/jerr/2023/v25i6940
[37] Albrechtsen, E., Solberg, I., Svensli, E. (2019). The application and benefits of job safety analysis. Safety Science, 113: 425-437. https://doi.org/10.1016/j.ssci.2018.12.007
[38] Mishra, K., Aithal, P.S. (2021). Job safety analysis during tunnel construction. International Journal of Applied Engineering and Management Letters, 5(1): 80-96. https://doi.org/10.47992/IJAEML.2581.7000.0094
[39] Priya, M.G.S., Anandh, K.S., Prasanna, K. (2022). A quantitative study on construction job safety analysis and occupational safety and health management. In Advances in Construction Management: Select Proceedings of ACMM 2021, pp. 355-368. https://doi.org/10.1007/978-981-16-5839-6_31
[40] Xiaoyong, L., Wendi, M. (2012). An investigation of safety management in construction workplace in China. Future Wireless Networks and Information Systems, 2: 321-329. https://doi.org/10.1007/978-3-642-27326-1_42
[41] Kim, N.K., Rahim, N.F.A., Iranmanesh, M., Foroughi, B. (2019). The role of the safety climate in the successful implementation of safety management systems. Safety Science, 118: 48-56. https://doi.org/10.1016/j.ssci.2019.05.008
[42] Bin Khairudin, A.H., Binti Abas, N.H. (2021). The practices of occupational safety and health management in construction industry: Case studies of high rise building projects. Journal of Structural Monitoring and Built Environment, 1(1): 10-17. https://doi.org/10.30880/jsmbe.2021.01.01.002
[43] Rice, S.P.M., Rimby, J., Hurtado, D.A., Gilbert-Jones, I., Olson, R. (2022). Does sending safety toolbox talks by text message to residential construction supervisors increase safety meeting compliance? Occupational Health Science, 6(3): 313-332. https://doi.org/10.1007/s41542-022-00118-8
[44] Olson, R., Varga, A., Cannon, A., Jones, J., Gilbert-Jones, I., Zoller, E. (2016). Toolbox talks to prevent construction fatalities: Empirical development and evaluation. Safety Science, 86: 122-131. https://doi.org/10.1016/j.ssci.2016.02.009
[45] Jeschke, K.C., Kines, P., Rasmussen, L., Andersen, L.P.S., Dyreborg, J., Ajslev, J., Kabel, A., Jensen, E., Andersen, L.L. (2017). Process evaluation of a toolbox-training program for construction foremen in Denmark. Safety Science, 94: 152-160. https://doi.org/10.1016/j.ssci.2017.01.010
[46] Eggerth, D.E., Keller, B.M., Cunningham, T.R., Flynn, M.A. (2018). Evaluation of toolbox safety training in construction: The impact of narratives. American Journal of Industrial Medicine, 61(12): 997-1004. https://doi.org/10.1002/ajim.22919
[47] Hallowell, M.R. (2012). Safety-knowledge management in American construction organizations. Journal of Management in Engineering, 28(2): 203-211. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000067
[48] Drupsteen, L., Guldenmund, F.W. (2014). What Is Learning? A Review of the safety literature to define learning from incidents, accidents and disasters. Journal of Contingencies and Crisis Management, 22(2): 81-96. https://doi.org/10.1111/1468-5973.12039
[49] Wu, T.C., Chen, C.H., Li, C.C. (2008). A correlation among safety leadership, safety climate and safety performance. Journal of Loss Prevention in the Process Industries, 21(3): 307-318.

https://doi.org/10.1016/j.jlp.2007.11.001
[50] Mohammad, A.H. (2022). The key performance index for the successful project phases in the construction industry. Journal of Jilin University (Engineering and Technology Edition), 41(4): 74-90. https://doi.org/10.17605/OSF.IO/QPCSV
[51] Schwatka, N.V., Goldenhar, L.M., Johnson, S.K. (2020). Change in frontline supervisors' safety leadership practices after participating in a leadership training program: Does company size matter? Journal of Safety Research, 74: 199-205. https://doi.org/10.1016/j.jsr.2020.06.012
[52] Ariyadi, E., Claudia, M. (2022). The role of safety leadership in safety behavior with safety climate as a mediation variable: A study on construction workers of Alfath group south Kalimantan (real estate developer). Open Access Indonesia Journal of Social Sciences, 5(5): 812-819. https://doi.org/10.37275/oaijss.v5i5.130
[53] Lingard, H., Zhang, R.P., Oswald, D. (2019). Effect of leadership and communication practices on the safety climate and behaviour of construction workgroups. Engineering, Construction and Architectural Management, 26(6): 886-906. https://doi.org/10.1108/ECAM-01-2018-0015
[54] Rani, H.A., Radzi, A.R., Alias, A.R., Almutairi, S., Rahman, R.A. (2022). Factors affecting workplace well-being: Building construction projects. Buildings, 12(7): 910. https://doi.org/10.3390/buildings12070910
[55] Acheamfour, V.K., Kissi, E., Adjei-Kumi, T. (2019). Ascertaining the impact of contractors pre-qualification criteria on project success criteria. Engineering, Construction and Architectural Management, 26(4): 618-632. https://doi.org/10.1108/ECAM-03-2018-0110
[56] Kukoyi, P.O., Osuizugbo, I.C., Yohanna, H.S., Edike, U.E. (2021). Pre-qualification of selecting construction project contractors using health and safety criteria. Journal of Engineering, Project, and Production Management, 11(1). https://doi.org/10.2478/jeppm-2021-0004
[57] Alshamrani, O.S.D., Saleem, M., AlYousif, I.K., Alluqmani, A. (2023). Development of a pre-qualification and selection framework for construction projects' contractors in Saudi Arabia. Journal of Asian Architecture and Building Engineering, 22(3): 1545-1563. https://doi.org/10.1080/13467581.2022.2087657
[58] Alzahrani, J.I., Emsley, M.W. (2013). The impact of contractors' attributes on construction project success: A post construction evaluation. International Journal of Project Management, 31(2): 313-322. https://doi.org/10.1016/j.ijproman.2012.06.006
[59] Mahmoudi, A., Javed, S.A. (2022). Performance evaluation of construction sub-contractors using ordinal priority approach. Evaluation and Program Planning, 91: 102022. https://doi.org/10.1016/j.evalprogplan.2021.102022
[60] Awais-E-Yazdan, M., Hassan, Z., Ejaz, A., Spulbar, C., Birau, R., Mitu, N.E. (2022). Investigating the nexus between safety training, safety rules and procedures, safety performance and protection against hazards in Pakistani construction companies considering its impact on textile industry. Industria Textila, 73(1): 48-53. https://doi.org/10.35530/IT.073.01.202154
[61] Hussain, R., Pedro, A., Lee, D.Y., Pham, H.C., Park, C.S. (2020). Impact of safety training and interventions on training-transfer: Targeting migrant construction workers. International Journal of Occupational Safety and Ergonomics, 26(2): 272-284. https://doi.org/10.1080/10803548.2018.1465671
[62] Marquardt, N., Hoebel, M., Lud, D. (2021). Safety culture transformation—The impact of training on explicit and implicit safety attitudes. Human Factors and Ergonomics in Manufacturing & Service Industries, 31(2): 191-207. https://doi.org/10.1002/hfm.20879
[63] Esfahani, M.T., Awolusi, I., Hatipkarasulu, Y. (2024). Effects of heat stress prevention training on the knowledge of construction students. Journal of Engineering, Project & Production Management, 14(2): 1-8. https://doi.org/10.32738/JEPPM-2024-0018
[64] Harvey, E.J., Pinder, J.A., Haslam, R.A., Dainty, A.R.J., Gibb, A.G. (2020). The use of actor-based immersive health and safety inductions: Lessons from the Thames tideway tunnel megaproject. Applied Ergonomics, 82: 102955. https://doi.org/10.1016/j.apergo.2019.102955
[65] Teck, A.G.P., Abdullah, M.N., Asmoni, M., Hamid, H.A., Misnan, M.S., Lee, J.Y., Jaafar, M.N. (2015). Evaluation criteria of safety and health induction for construction worker (SICW) in Malaysia. Jurnal Teknologi (Sciences & Engineering), 73(5). https://doi.org/10.11113/jt.v73.4325
[66] Zakaria, M.N.S., Salleh, N.A., Nawi, M.N.M. (2016). Impact of serious game towards foreign worker in safety induction course in Malaysian construction industry. Technical Journal of the Faculty of Engineering, 39(9): 1-8. https://doi.org/10.21311/001.39.9.01

NOMENCLATURE

L	Leadership
TC	Training and Competency
CP	Communication and Promotion
RE	Risk Evaluation
PA	Planning and Administration
AM	Asset Management
PM	Project Management
HR	Human Resources
CA	Compliance Assurance
RC	Risk Control
CSM	Contractor & Supplier Management
EP	Emergency Preparedness
LI	Learning from Incidents
RM	Risk Monitoring
RR	Results and Review
SUCC	Success of Incident Prevention
OPS	Overall Project Success
AVE	Average Variance Extracted
HTMT	Heterotrait-monotrait Ratio
VIF	Variance Inflation Factor
R^2	Coefficient of Determination
RMSE	Root Mean Square Error
MAE	Mean Absolute Error
LM	Linear Regression Benchmark
O	Original Sample
M	Sample Mean
STDEV	Standard Deviation

Greek symbols

α	Cronbach's Alpha
ρ_c	Composite Reliability