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The Impact of Safety Culture on Workers' Safety Motivation and Behavior in Vietnam's Construction Industry

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ABSTRACT

Construction is a sector where occupational safety is crucial, as it is the sector with the highest rates of accidents and risks. Safety culture helps reduce accidents and injuries by directly influencing workers' safety behavior. However, in the construction industry, studies on safety culture remain limited, particularly in developing nations like Vietnam. The purpose of this study is to determine the aspects of safety culture that affect safety motivation and safety behavior among workers in construction companies in Vietnam. Based on data collected from 495 workers at major construction companies in Vietnam, the investigation utilised structural equation modelling (SEM) to assess the research hypotheses. The findings of the study show that safety culture plays a significant role in fostering workers' safety motivation and safety behavior in the Vietnamese construction sector. Therefore, construction companies can enhance individual safety motivation and improve workers' safety behavior by building and fostering a strong safety culture through the aspects of safety culture presented in this study.

1. INTRODUCTION

The construction industry has a working environment with higher levels of hazards and risks than other industries because construction activities often take place outdoors under conditions that are not conducive to safety and health. At construction sites, workers are subject to constant changes in the work location, nature of work, and combination of workers [1]. In Vietnam, according to a report by the Ministry of Labor, Invalids, and Social Affairs, there were 6,879 occupational accidents in 2023, resulting in 530 deaths and 1,547 serious injuries. When compared to other sectors, the construction sector experienced the most accidents, accounting for 18.27% of total incidents and 20.03% of total deaths [2]. Safety management in the construction sector still faces many challenges, especially in small-scale projects where safety awareness and compliance with regulations remain limited. In the past, the dangerous behaviours of construction workers have been identified as a primary factor in accidents [3]. Researchers have indicated that risky behaviour accounts for roughly 80% of construction incidents [4]. According to Al-Bayati [5], safety culture in construction should be considered the root cause of incidents because it significantly influences safety behavior. Lack of safety culture leads to unsafe behavior, which ultimately leads to more frequent construction incidents. To enhance the performance of occupational safety management, companies need to build a sustainable safety culture that combines regulatory compliance with workers' self-discipline, thereby ensuring a safer working climate.

The concept of safety culture has gained attention recently because of its role in reducing accidents and injuries [6, 7]. However, the lack of specific measurement indicators for safety culture is a significant obstacle to improving it [7]. Reiman and Rollenhagen [8] contend that another reason for this may be that numerous organisations lack comprehension regarding the effective development of a safety culture. According to Hee and Ping [9], the most common indicators for evaluating an organization's safety performance include the number of accidents, lost time injuries, fines, and penalties for violations. These indicators are often considered reactive indicators, only reflecting the situation after an incident has occurred; using these indicators alone is not sufficient to reflect the organisation's safety performance. To ensure the organisation's safety performance, proactive safety measures must be implemented to prevent incident occurrence. Therefore, it is important to focus on the human factor and the organisational environment, as the combination of these two elements determines the overall safety performance of the organization. Good safety performance, marked by the absence of incidents, should be monitored proactively rather than reactively [10]. In this case, culture plays a crucial role as it guides human behavior and establishes norms within the organization [11]. At the same time, employees working in teams must adhere to rules and regulations to maintain safety standards. At this point, safety culture helps shape individual safety behavior and fosters interaction between people, functions, and the organization [12]. Therefore, safety culture can be considered as the foundation for workers' safety

behavior.

Safety culture is often divided into various dimensions to provide a comprehensive view of safety culture in a specific organization. The aspects of safety culture and its impact on employee attitudes and behaviors have been examined in various studies. In order to determine how safety management systems affect employee participation in occupational safety initiatives, Gao et al. [13] looked at the safety culture in the Chinese oil and gas sector. They did this by analysing a number of aspects, such as organisational accountability, leadership commitment, collaboration and information dissemination, safety training, and supervision and inspection. The research results in the Japanese oil and gas sector also indicate that safety culture positively impacts safety motivation, error behavior, and employee violations [6]. However, there aren't many studies looking at safety culture and how it affects worker reactions in the construction industry. Research on safety culture is notably scarce in emerging nations such as Vietnam [14]. Therefore, this research aims to identify the constitutive factors that form the basis for evaluating safety culture and to examine the effect of safety culture on workers' safety motivation and behavior in the construction industry in Vietnam. The research findings will assist managers in evaluating the current circumstances and fostering a safety culture within organisations to enhance workplace safety performance in construction firms in Vietnam.

2. LITERATURE REVIEW

2.1 Safety culture

According to Booth and Lee [15], the International Atomic Energy Agency's (IAEA) Nuclear Safety Advisory Group created the notion of Safety Culture when examining the Chernobyl disaster in relation to nuclear safety. IAEA (1986) defined an organization's safety culture as the culmination of the attitudes, values, competencies, and behavioral patterns of individuals and groups that influence the commitment, approach, and effectiveness of the organisation's health and safety initiatives. This definition has been accepted by many experts studying safety and is summarized as follows: Safety culture represents a subset of organizational culture, encompassing the attitudes, beliefs, values, and behaviors of individuals and groups in relation to occupational safety and health within an organization [8, 16].

According to Cooper [17], safety culture is a component of organisational culture that is thought to influence members' attitudes and behaviors towards the organization's continuous safety and health performance. The significance of safety culture in enhancing organizational safety performance through a decrease in accidents and disasters has been emphasized by certain safety researchers. Accident rates are lower in companies with a strong safety culture than in those with a weak one [18, 19]. Despite the longstanding recognition of safety culture's significance, organisations continue to encounter considerable challenges in enhancing safety culture owing to an absence of safety culture measurements [20]. Another explanation for this may be because organisations lack comprehension of how safety culture is cultivated; as safety culture is a subculture of corporate culture, altering it is more complex than one may assume [8].

2.2 Safety culture dimensions

To be able to assess the status of the safety culture of a particular organization, it is necessary to identify the dimensions that reflect the organization's safety culture. Although scholars have studied the dimensions of safety culture thoroughly, there are various perspectives on these dimensions. Sometimes, the dimensions are classified in a general way, while other times they are categorized in more detail. Maturity models of safety culture are often used to identify the dimensions of safety culture.

The safety culture maturity model proposed by Fleming [20] divides safety culture into dimensions to provide a broad picture of how safety culture is doing within a particular organisation. According to Tappura et al. [7], based on the analysis in Leal Filho et al. [21], the five most prevalent dimensions in models of safety culture maturity across diverse industries are management commitment, employee commitment, safety training, safety communication, and organisational learning.

Besides, the determination of components of safety culture in the construction sector has been conducted by many studies in the world in recent times. Choudhry et al. [16] conducted a study and confirmed 5 components of safety culture in the construction sector in Hong Kong, including management commitment, work practices, safety values, safety rules and procedures, and employees' involvement. Mohamed et al. [22] evaluated the safety culture of companies in the construction sector in Pakistan through 7 dimensions, including management commitment, awareness and beliefs, safety training, safety values, work environment, risk assessment, and peer supports. Wu et al. [23] studied the safety culture of construction companies in China through 10 aspects: leadership, safety procedures' awareness, communication, training, safety management system, reward systems, supervision, work pressure, risk assessment, social security, and emotional state.

The review of selected documents shows that each safety culture model has different aspects in each country. However, each model has common components used, such as safety awareness, safety training, and management commitment. Therefore, these can be considered important components used mainly to assess safety culture in the construction sector. However, to identify the aspects of safety culture suitable for the companies in the Vietnamese construction industry, a discussion on this issue was conducted based on the contributions of 10 experts who are safety managers and supervisors at construction companies. The results from the experts all agreed and confirmed that the 5 commonly used components in the safety culture maturity model, including 3 main aspects of the safety culture of companies in the construction sector used in other countries, are suitable and can be used to assess the safety culture of construction companies in Vietnam.

To ensure the success of any safety program, the support and commitment of management are extremely important. Employees look to management for inspiration and motivation, and they form many of their attitudes based on their observations of those at the top [7, 16]. In organizations with an underdeveloped safety culture, employees perceive a gap between what management says and does, whereas in companies with a strong safety culture, management appears genuinely committed to safety, and they follow through on what they say. In short, the stronger the commitment of

management to safety, the more mature the organization's safety culture [24].

The employee commitment component reflects how safety is perceived by employees within the organization [7]. Numerous prior studies indicate that employee safety awareness is a key factor in predicting safety culture within the proposed research model. This may serve as a sign of a facet of the safety culture that is crucial for evaluating the level of overall safety culture according to the theoretical framework [16, 17, 20]. Employee safety awareness relates to how an employee feels about safety as an approach, a value; in organizations where employees feel that safety is something done for them rather than something they should do, the safety culture is not well developed. As the organization becomes more mature in its perspective on safety culture, a majority of employees will share the belief that safety is important, and this will ultimately develop into a perspective that continuous improvement in safety is a natural way of working [24].

According to Fleming [20] and Daher [24], safety communication is crucial in improving a positive safety environment; in organizations where safety culture is still in its early stages, communication tends to be one-way, closed, and authoritative, often taking the form of providing safety information. Organizations with a stronger safety culture will have mechanisms for two-way communication, offering many opportunities for feedback and improvement, and a clear, open dialogue between management and employees will continuously take place. Safety training is also an important aspect in determining the type of safety culture prevalent within an organization; in workplaces where the safety culture is still in its initial stages, training primarily takes the form of information provision. As the organization's safety culture becomes more mature, training takes on a more important role and becomes a key element in encouraging employee proactive safety behavior. Organizational learning, or the ability to learn from mistakes, is also an important indicator of an organization with a strong safety culture; organizations with clear risk or accident reporting systems are often those with a stronger safety culture, as they share these findings with all employees and ensure that they are aware of the lessons learned. In contrast, organizations with a less developed safety culture are those that only investigate certain aspects of incidents and often lack a clear accident reporting system, let alone sharing the results of any investigations conducted.

This study examines the safety culture of construction companies in Vietnam as a multi-dimensional concept assessed through five key dimensions: (1) management commitment, (2) employee safety awareness, (3) safety communication, (4) safety training, and (5) organizational learning.

3. STUDY HYPOTHESES

Safety culture is defined by characteristics such as leadership commitment, effective safety systems, and support in risk management [25]. These characteristics are established to create a climate where workers are encouraged to participate in safety activities while receiving full support to perform safe behaviors. The existence of a positive safety culture can significantly influence employees' perceptions and attitudes toward the necessity of safety, thereby enhancing intrinsic motivation to maintain and perform safe behaviors [26]. Studies also show that when employees feel their work climate is safe and they are actively involved in safety procedures, their safety motivation increases, leading to greater compliance with regulations and higher participation in safety activities [27]. Therefore, building a safety culture not only influences perception but also fosters employees' commitment and motivation to protect their own safety and the surrounding environment [5, 6]. Thus, hypothesis H1 is proposed:

H1: Personnel safety motivation in Vietnamese construction companies is positively impacted by safety culture.

Neal and Griffin [28] assert that compliance and participation are two aspects of employee safety behavior. Safety compliance denotes the degree to which personnel conform to the organization's safety regulations, procedures, and standards. Meanwhile, safety participation is the proactive involvement of employees in safety-related activities, such as proposing improvements, supporting colleagues, and promoting a safer work environment [9].

A work environment with a strong safety culture will encourage employees to comply with safety rules because they feel that these policies are designed to protect their health and safety rather than simply to meet mandatory regulations. The study by Abeje and Luo [26] shows that safety culture directly influences employees' safety performance and related factors through compliance and participation with the safety goals of the organization. Additionally, another study by Christian et al. [29] further supports the notion that safety culture has a positive impact on safety compliance and safety participation. According to this study, workers will be more proactive in following safety regulations and taking part in activities that improve the safety working environment if they believe that their company appreciates safety. Therefore, establishing a strong safety culture foundation not only improves safety compliance but also motivates employees to actively participate in safety-related activities, contributing to risk reduction and enhancing work efficiency. Numerous additional studies have highlighted the significance of safety culture in shaping employee safety behaviour across different contexts, such as Çakıt et al. [6] and Hien et al. [14]. Therefore, hypotheses H2a and H2b are proposed:

H2a: Safety compliance among workers in Vietnamese construction companies is positively impacted by safety culture.

H2b: Safety participation among workers in Vietnamese construction companies is positively impacted by safety culture.

Safety motivation refers to an individual's readiness to participate in safety practices and the significance attributed to those actions [28]. This motivation serves to promote compliance behaviors, such as ensuring that employees follow safety rules and regulations, as well as safety participation behaviors such as supporting coworkers and contributing to a safer work environment [30]. Previous studies have also shown that when safety motivation is enhanced, employees tend to demonstrate better compliance with safety regulations due to a sense of voluntariness and responsibility [31]. At the same time, safety motivation also encourages safety participation behaviors such as sharing best practices and reporting potential hazards, contributing to a positive work environment, and reducing risks [32, 33]. Therefore, both safety compliance and participation lead to improved safety outcomes in the organization, including a reduction in accidents and unwanted incidents [30]. Therefore, hypotheses H3a and H3b are proposed as follows:

H3a: Worker's safety compliance in Vietnamese

construction companies is positively impacted by personnel safety motivation.

H3b: Worker's safety participation in Vietnamese construction companies is positively impacted by personnel safety motivation.

Figure 1 summarises the suggested research model and displays the research hypotheses.

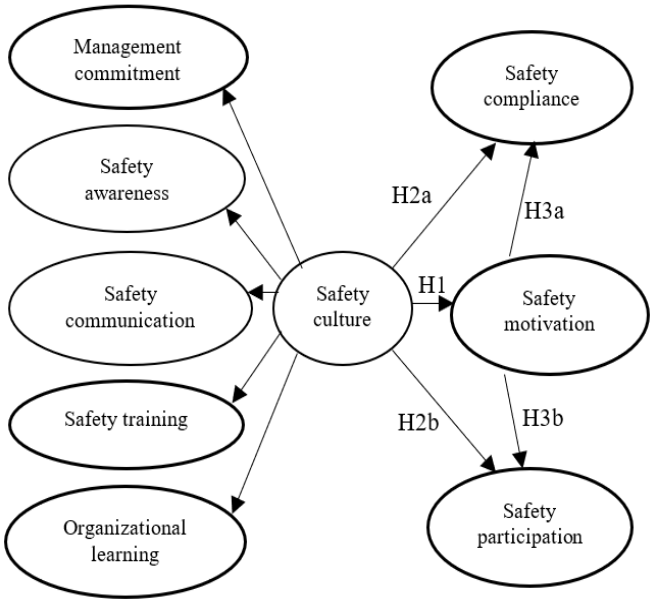

Figure 1. Proposed research model

4. RESEARCH METHODOLOGY

4.1 Measurement of research variables

The measurement scales for the concepts in the research model are adapted and modified from previous studies' scales within the relevant context. Safety culture is a second-order latent variable assessed through five component scales, including management commitment (5 observed variables) and safety awareness (6 observed variables), which are adapted from Al-Bayati [5]. The safety communication scale (5 observed variables) and the scale of safety training (4 observed variables) are also adapted from the studies of Hee and Ping [9]. The organizational learning scale (3 observed variables) is derived from the research of Al-Bayati [5]. The scales for personnel safety motivation (5 observed variables), safety compliance (4 observed variables), and safety participation (5 observed variables) are adapted from the studies of Hee and Ping [9]and Neal and Griffin [28].

In addition, a discussion with 10 experts who are safety managers and supervisors from construction companies in Vietnam was conducted to check the cultural and linguistic equivalence of the scales. Based on their opinions, the scales were reworded and expressed to better fit the Vietnamese context.

The measurement scales for the first-order ideas in this study are initially evaluated by exploratory factor analysis (EFA) and the cronbach's alpha reliability coefficient. Subsequently, structural equation modelling (SEM) and confirmatory factor analysis (CFA) are utilised to examine and analyse the latent components and the interrelationships among the study topics.

4.2 Research sample

Hair et al. [34] require that the minimum requisite sample size must be no less than five times the number of observed variables in the analysis, with an optimum target of ten times. In this study, there are a total of 37 observed variables, so the minimum sample size is 185 observations. A quota sample was determined based on age and years of experience (Table 1). The questionnaire was distributed through direct surveys of workers at major construction sites in Vietnam or online surveys via Google Forms sent through personal Zalo accounts. As a result, 495 valid responses were obtained for the research data, and the structure of the research sample is presented in Table 1.

Of the 495 workers surveyed, the number of workers aged 26 to 45 accounted for a higher proportion compared to those under 26 and over 45; the number of workers with 5 to 20 years of experience was higher than those with less than 5 years and over 20 years. The distribution of the research sample is representative and aligns with the characteristics of the workforce in the construction sector in Vietnam. This can be explained by the nature of the work of construction workers requiring good health and tolerance to harsh working conditions, suitable for the young, newly graduated labor force, so the number of workers aged 26-45 accounts for a larger proportion, and the number of workers aged over 45 years old and the number of workers with working time over 20 years accounts for a smaller proportion.

Table 1. Profile of respondents (n=495)

Demographic Characteristics	Frequency	Percentage
Age		
Less than 26	94	18.99
26 – 35	192	38.79
36 – 45	146	29.49
Older than 45	63	12.73
Work experience		
Less than 5 years	103	20.81
5 - 10 years	189	38.18
11 - 20 years	152	30.71
More than 20 years	51	10.30

5. RESULTS

5.1 Measurement model

The results of the reliability test for the scales show that, except for the observed variables SC5 and PSP5, which had a total correlation coefficient < 0.3 and were thus excluded, the remaining observed variables all had total correlation coefficients greater than 0.3 and Cronbach's alpha values > 0.70 (Table 2). These values provide evidence of the internal reliability of the research constructs [34].

The results of the exploratory factor analysis (EFA) show that the eigenvalue > 1, the extracted variance > 50%, and the factor loadings > 0.5 (as presented in Table 2), indicating that the scales meet the requirements and can proceed to CFA analysis.

5.1.1 The results of CFA analysis for the second-order construct

The data shown in Table 3 suggests that the composite reliability (CR) for the component scales varies between 0.875 and 0.935, with all values exceeding 0.7.

The component scales average variance extracted (AVE) values greater than 0.5 show that they attain convergent validity. The square root values of AVE exceed the correlations among the latent variables, and the maximum shared variance (MSV) values are less than AVE, so confirming discriminant validity [35].

Table 2. Results of reliability testing and EFA analysis

Constructs	Number of Items	Total Correlation Coefficient	Cronbach's Alpha	Extracted Variance	Loading
Management commitment	5	0.792 – 0.866	0.935		0.771 - 0.951
Safety awareness	6	0.676 – 0.761	0.898		0.682 – 0.831
Safety communication	4	0.720 – 0.792	0.888	73.835%	0.655 – 0.910
Safety training	4	0.643 – 0.792	0.876		0.629 – 0.867
Organizational learning	3	0.722 – 0.803	0.872		0.766 – 0.958
Safety motivation	5	0.639 – 0.776	0.885		0.675 – 0.851
Safety compliance	4	0.719 – 0.764	0.879	72.245%	0.742 – 0.884
Safety participation	4	0.616 – 0.714	0.848		0.514 – 0.860

Table 3. Convergent and discriminant validity of the component scales of safety culture

	CR	AVE	MSV	MaxR(H)	MC	SA	ST	CO	SL
MC	0.935	0.744	0.370	0.939	0.862				
SA	0.898	0.597	0.251	0.904	0.459***	0.772			
ST	0.879	0.646	0.337	0.892	0.580***	0.416***	0.804		
CO	0.890	0.669	0.370	0.894	0.608***	0.501***	0.577***	0.818	
SL	0.875	0.701	0.336	0.882	0.461***	0.387***	0.458***	0.580***	0.837

Notes: *** ($p < 0.001$); MC (Management commitment); SA (Safety awareness); ST (Safety training); CO (Safety communication); SL (Organizational learning).

The assessment of the observed variables' quality reveals that all p-values are below 0.05, signifying the significance of each variable within the model; additionally, the standardized weights exceed 0.5 (Figure 2), indicating a high level of fit for all observed variables.

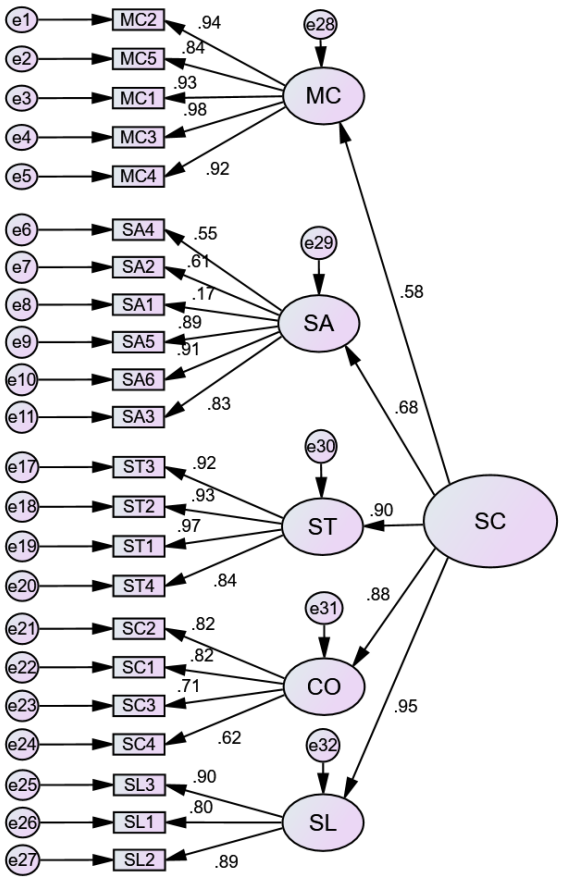

Figure 2. The results of CFA analysis for the second-order construct

The results demonstrate that the components are significant in explaining safety culture (SC), as indicated by the p-values of all the components being less than 0.05. The components' standardized weights are greater than 0.5 (Figure 2), indicating that each one makes a significant contribution to safety culture (SC) [36].

5.1.2 The results of CFA analysis for the overall model

According to Hair et al. [34], the following indicators are used to evaluate the model's fit: The CMIN/DF value measures the model's fit in greater detail; a value below 5 is considered acceptable. The Goodness of Fit Index (GFI) measures the proportion of variance accounted for by the sample covariance matrix, which is greater than 0 and less than 1. The GFI value of 0.9 or higher indicates a good fit; however, due to sample size limitations, achieving a GFI of 0.9 can be challenging. This index is highly dependent on the number of scales, observed variables, and sample size, so a threshold of 0.8 may be acceptable. The Comparative Fit Index (CFI) compares the fit of this model to that of another model using the same dataset. The CFI value is greater than 0 and less than 1; a better fit is indicated by values nearer 1. The Tucker-Lewis Index (TLI) has a similar purpose, but its range can exceed 1. A good model fit is indicated when both CFI and TLI values are greater than or equal to 0.9. The Root Mean Square Error of Approximation (RMSEA) accounts for approximation error in the population. A good model fit is indicated by RMSEA values of 0.08 or less.

The model fit indices all meet the standards: CMIN/DF = 2.850 < 3, GFI = 0.854 > 0.8, CFI = 0.920 > 0.9, TLI = 0.912 > 0.9, RMSEA = 0.061 < 0.08, indicating that the model has achieved a high level of fit [36].

All of the observed variables, with the exception of SA1 and PSC4, had standardized weights larger than 0.5 (Table 4). Accordingly, all of the observed variables are significant in the model and serve as good indicators for the components they load onto [36].

Table 4. Measurement dimensions, items, factor loadings

Dimensions	Items	Loadings
Management commitment	MC1. Management prioritises safety inside the company.	0.828
	MC2. Management allocates resources to avert the occurrence of incidents.	0.895
	MC3. Management endeavours to enhance workplace safety or mitigate safety issues.	0.851
	MC4. Management expresses apprehensions on the safety and welfare of their employees.	0.841
	MC5. Management personally engaged in safety training.	0.894
Safety awareness	*SA1. I am cognisant of my coworkers who disregard safety norms and regulations.*	*Remove*
	SA2. I consult the supervisor when I have safety concerns at work.	0.776
	SA3. I cease working if I am uncertain about the safety of my tasks.	0.846
	SA4. In situations of uncertainty regarding safety, I exercise extreme cautio.	0.665
	SA5. I am acutely cognisant of the safety hazards inherent in my profession.	0.802
	SA6. I will communicate the risks associated with my employment.	0.818
Safety communication	SC1. A suggestion box or regular meetings are proposed for conveying opinions to management.	0.851
	SC2. Information systems provide access to inform employees before alterations and adjustments in work procedures.	0.850
	SC3. Circulars are disseminated to alert employees about the hazards related to their occupations.	0.780
	SC4. Open discussion regarding safety concerns exists in this workplace.	0.788
	SC5. Meetings provide ample chance to address and resolve safety concerns.	*Remove*
Safety training	ST1. Employees receive sufficient training while commencing difficult, evolving roles or employing new methodologies.	0.787
	ST2. Training activities are continuous and periodic, included within the officially established training framework.	0.867
	ST3. Management facilitates employee participation in safety training programs.	0.851
	ST4. The safety training I received is sufficient for me to evaluate workplace hazards.	0.788
Organizational learning	SL1. Accident investigations aim to discover deficiencies in workplace safety procedures, rather than assign blame.	0.790
	SL2. The reasons of accidents are investigated to enhance workplace safety systems.	0.835
	SL3. Employees are provided with knowledge regarding the causes of workplace accidents.	0.884
Personnel safety motivation	PSM1. I believe it is valuable to exert effort in preserving or enhancing my personal safety.	0.690
	PSM2. I believe it is crucial to uphold safety at all times.	0.834
	PSM3. I contend that it is essential to mitigate the risk of accidents and incidents in the workplace.	0.813
	PSM4. I believe it is essential to promote the use of safe practices among others.	0.760
	PSM5. I believe it is essential to advocate for safety programs.	0.802
Personnel safety compliance	PSC1. I utilise the requisite safety equipment to do my duties.	0.756
	PSC2. I adhere to appropriate safety regulations and protocols when performing my duties.	0.836
	PSC3. I guarantee the utmost safety standards in the execution of my duties.	0.775
	PSC4. I perform my duties safely.	*Remove*
Personnel safety participation	PSP1. I advocate for the safety program throughout the organisation.	0.777
	PSP2. I exerted additional effort to enhance workplace safety.	0.815
	PSP3. I willingly undertake jobs or activities that enhance workplace safety.	0.778
	PSP4. I urge my colleagues to prioritise safety in their work.	0.696
	PSP5. I consistently inform management of any observed safety-related issues within my organisation.	*Remove*

Table 5. Convergent and discriminant validity of the scales in the overall model

	CR	AVE	MSV	MaxR(H)	PSM	PSC	PSP	SC
PSM	0.886	0.611	0.469	0.893	0.781			
PSC	0.832	0.624	0.507	0.838	0.599***	0.790		
PSP	0.851	0.590	0.469	0.857	0.685***	0.579***	0.768	
SC	0.840	0.516	0.507	0.860	0.480***	0.712***	0.557***	0.718

Notes: *** ($p < 0.001$); PSM (Personnel safety motivation); PSC (Personnel safety compliance); PSP (Personnel safety participation); SC (Safety culture).

Table 5 demonstrates that the CR values exceed 0.7 and the AVE values surpass 0.5, signifying that the scales guarantee convergent validity [36]. The square root values of AVE are greater than the correlations among the latent variables, but the MSV values are inferior to AVE, hence confirming discriminant validity [35].

5.2 Structural model

The study's hypotheses were evaluated utilizing a covariance-based structural equation model (CB-SEM). The fit indices results satisfy the prescribed model criteria: $\chi^2/df = 2.848 < 3$; GFI = 0.854 > 0.8; TLI = 0.912 > 0.9; CFI = 0.920 > 0.9; and RMSEA = 0.025 < 0.08 (Hair et al., [34]). The statistical indices indicate that the theoretical model aligns with the survey dataset.

Figure 3 displays the structural model with standardized path coefficients. Table 6 presents the calculated path coefficients among the latent variables. The hypotheses were all corroborated by the survey findings. The analysis provides the subsequent results.

The safety culture (SC) exerts a substantial beneficial influence on personnel safety motivation (PSM) inside construction businesses in Vietnam ($\beta = 0.528$; p-value < 0.05).

Hypothesis H1 is confirmed, indicating the dominant role of safety culture as a predictor to enhance the safety motivation of workers in the construction industry in Vietnam.

The safety culture (SC) has a significant positive effect on personnel safety compliance (PSC) with $\beta = 0.460$; p-value < 0.05. Personnel safety participation (PSP) in Vietnamese construction enterprises is significantly positively impacted by safety culture (SC) with $\beta = 0.374$; p-value < 0.05. Therefore, hypotheses H2a and H2b are supported. This suggests that construction companies in Vietnam can improve worker safety compliance and participation through developing a strong safety culture within their organizations.

The role of personnel safety motivation for employee safety behavior is confirmed through the supported hypotheses H3a and H3b with a p-value < 0.05. The influence of personnel safety motivation on employee safety participation is significant ($\beta = 0.255$), and it also positively affects employee safety compliance ($\beta = 0.606$). This confirms that in construction companies in Vietnam, workers with high safety motivation tend to have higher safety compliance and participation than other workers.

The R^2 value reveals that safety culture accounts for 23.0% of the variance in employee safety motivation. Additionally, safety culture and personnel safety motivation together explain 60.0% of the variance in employee safety compliance, while 54.4% of the variance in employee safety participation is attributed to safety culture and personnel safety motivation among workers in construction companies in Vietnam (Table 6).

Table 6. Hypothesis testing results

Hypothesis	Relationship	Unstandardized Regression Coefficients	Standardized Regression Coefficients	P-Value	Test Result	R^2
H1	PSM <-- SC	0.528	0.480	***	Accepted	0.230
H2a	PSC <-- SC	0.460	0.554	***	Accepted	0.600
H3a	PSC <-- PSM	0.255	0.337	***	Accepted	
H2b	PSP <-- SC	0.374	0.304	***	Accepted	0.544
H3b	PSP <-- PSM	0.606	0.542	***	Accepted	

Notes: *** (p < 0.001); SC (Safety culture); PSM (Personnel safety motivation); PSC (Personnel safety compliance); PSP (Personnel safety participation).

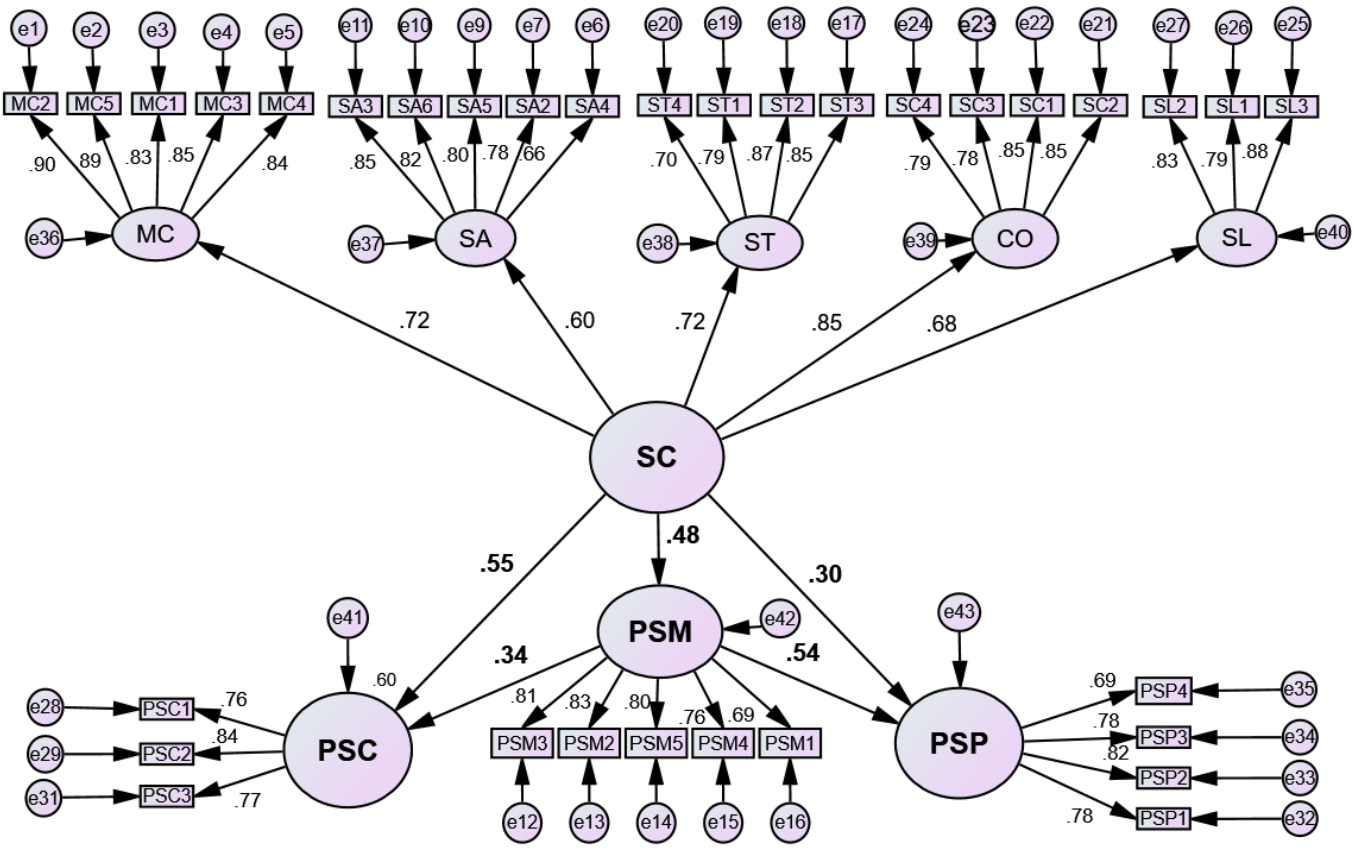

Figure 3. The structural model with standardized path coefficients

6. DISCUSSION

Safety culture is frequently recognised as a critical determinant of safety performance; yet, organisations have challenges in enhancing safety culture, despite the plethora of accessible measurement indicators [7]. Based on the research of Parker et al. [18], Gordon et al. [37], Kirk et al. [38], Reiman and Pietikäinen [39], Tappin et al. [40], and Tappura et al. [7], as well as Fleming's [20] safety culture maturity model, this study supports the opinion of analysing and measuring safety culture as a multi-dimensional concept. The study examines the safety culture of construction companies in Vietnam as a

second-order construct conceptualised by five key dimensions, with safety communication playing the highest role in the safety culture of Vietnamese construction companies (loading factor = 0.85), followed by management commitment and safety training (loading factor = 0.72), organizational learning (loading factor = 0.68), and employee safety perception (loading factor = 0.60). These dimensions can help companies analyze, assess the current situation and support the development of a safety culture in an organisation.

The research findings indicate that the safety culture inside construction organisations positively influences employee safety motivation. This finding is consistent with previous studies by Al-Bayati [5] and Çakıt et al. [6]. The supported hypotheses H2a and H2b indicate that safety culture has been shown to have a significant impact on the formation of personnel safety behavior through safety compliance and safety participation of employees in the construction sector; this result is consistent with previous studies by Al-Bayati [5], Çakıt et al. [6], and Hien et al. [14]. The role of personnel safety motivation for employee safety behavior is demonstrated through the supported hypotheses H3a and H3b, which align with previous studies by Neal and Griffin [28] and Vinodkumar and Bhasi [41]. These findings suggest that organisations with a favourable safety culture can establish an unspoken duty for employees to participate in safety initiatives. Employees in organisations with a favourable safety culture will exhibit greater motivation to engage in safety activities compared to those in organisations with a bad safety culture. In addition, employees with high safety motivation are more likely to engage in safety behaviors. Therefore, construction companies can enhance personnel safety motivation and improve employee safety behavior by building and developing a strong safety culture in the organization. These findings highlight the need to assess and strengthen the safety culture of companies in the construction industry.

7. CONCLUSION AND IMPLICATIONS

This study aimed to investigate the principal aspects of safety culture within the construction sector and to evaluate the correlation among organisational safety culture, safety motivation, and the safety behaviours of workers in Vietnam's construction industry. The research results offer numerous theoretical and practical insights beneficial to both researchers and building firms in Vietnam.

7.1 Theoretical implications

Firstly, this study further expands the understanding of the path toward a strong safety culture by identifying key dimensions that represent construction safety culture, including management commitment, employee perception, safety training, safety communication, and organizational learning. These aspects are inherited from Tappura et al. [7], based on the synthesis and analysis by Goncalves Filho and Waterson [42] of safety culture maturity models. However, this study's findings indicate that in the specific context of the construction industry in Vietnam, the role of these aspects in safety culture differs from other industries or countries. Specifically, the aspect of safety communication plays the most significant role, followed by management commitment, safety training, organizational learning, and finally, workers' safety awareness. This confirms that in different specific contexts, the role of these aspects in shaping safety culture varies. Secondly, the paper presents a theoretical framework, on the basis of which a research model is proposed to demonstrate the relationship between safety culture, safety motivation, safety compliance, and safety participation of the Vietnamese construction workers. Thirdly, the research has inherited and developed measurement scales for the concepts in the research model, and the testing results show that the measurement scales achieve reliability and validity. Fourthly, this study is at the forefront of investigating the impact of safety culture on workers' safety motivation and behavior in Vietnam's construction industry. The research findings offer robust empirical validation for the suggested theoretical framework. The study's findings demonstrate a statistically significant effect of safety culture on individual safety motivation and behavior, highlighting how crucial safety culture is as an element of corporate culture that impacts workers' safety behavior.

7.2 Practical implications

This study has practical significance for companies in the construction industry in Vietnam. In the context of frequent workplace accidents, enhancing safety performance and minimizing the number of accidents and casualties at construction sites in Vietnam is crucial and urgent. To achieve this, developing a strong safety culture is essential, as the results of this study indicate that safety culture plays a crucial role in fostering safety motivation and safe behavior among workers. Therefore, by developing the key aspects of safety culture presented in this study, construction businesses in Vietnam can work to increase workers' safe behavior and safety motivation, ultimately enhancing safety effectiveness inside the company.

This study's major characteristics of safety culture serve as a framework for construction organisations to assess their strengths and weaknesses, facilitating the development of continuous improvement programs and corrective measures. Organisations' safety performance may be evaluated using these dimensions as an efficacy indicator. Additionally, construction companies in Vietnam can use the criteria from this study to continuously assess the safety behaviors of employees. Giving them regular feedback might help them become more conscious of safety concerns and may motivate them to improve their performance in terms of safety.

The research results indicate that safety communication plays the highest role in construction safety culture; therefore, creating an effective safety communication environment is the foundation for building a strong safety culture. Construction companies need to have suggestion boxes or regular meetings to convey employees' perspectives and feedback on workplace safety to management. An information system should be established to inform employees before any safety-related modifications and changes. There should be documents to inform workers about the risks related to their work, and an open communication environment should be created so that employees can discuss any safety issues with management/supervisors at the workplace.

Next is management commitment. To build a strong safety culture in construction companies, managers need to prioritize safety and allocate resources for the company's safety efforts. Management must lead by example in implementing safety practices, ensuring consistency between what they say and do to inspire and motivate employees. This will shape workers'

safety behaviors based on their beliefs about their managers.

Safety training also plays a crucial role in developing a construction safety culture; therefore, safety training activities must occur continuously, regularly, and be integrated into the company's formal training program. Company leadership needs to actively support employees in participating in safety training programs. The training programs must enable employees to assess hazards in the workplace, and workers must receive adequate training when entering complex jobs, making changes, or using new techniques.

Another key dimension of construction safety culture is organizational learning. Organizations with clear risk or accident reporting systems often have a stronger safety culture. Therefore, information about the causes of accidents must be shared with all employees to ensure they are aware of the lessons learned. Investigating the causes of accidents should aim to improve the company's safety management system rather than to punish.

Finally, construction companies need to raise workers' awareness of occupational safety by propagating and educating through seminars, dialogues, training sessions, and training programs, contributing to helping workers grasp safety knowledge and effectively implement the company's occupational safety processes and policies.

The above has also been confirmed from the practice in the Vietnamese construction sector in recent times. Survey data shows that the safety compliance and participation of workers in large construction companies in Vietnam, such as Coteccons and Vinaconex, are higher than those of smaller construction companies. These companies have common points, such as they have a good safety communication system, strong attention and support from the management, safety training programs are promoted and take place regularly, they are always interested in improving safety procedures from shortcomings and mistakes through risk and accident reports, and they always share these reports with all workers to ensure that their workers are aware of the lessons learned.

7.3 Limitations and future research

It is also necessary to recognize the limitations of this study. First, it follows Tappura et al.'s [7] perspective in identifying the most common dimensions for analyzing and measuring the safety culture of companies in the construction industry; however, there are various viewpoints on the aspects of safety culture. Sometimes the aspects are classified in a general way (e.g., Cooper [17]); other times the aspects are classified in more detail [20]. Therefore, future studies could approach the dimensions of safety culture from different perspectives. Second, this study is a cross-sectional study, with data collected over a specific period from large construction companies in Vietnam. Consequently, the opinions of those who responded to the survey represent the safety culture as it exists at a certain moment in time and may alter at other times based on shifts in the safety culture inside their organisations. This study validates the proposed conceptual model and provides an empirical foundation for comparison with future research. Furthermore, subsequent investigations ought to examine the distinctions among subcultures that have emerged within the broader safety culture in comparably high-risk sectors, including petrochemicals, port operations, aviation, heavy industrial manufacturing, and mining, etc.

REFERENCES

[1] Misnan, M.S., Mohammed, A.H. (2007). Development of safety culture in the construction industry: A conceptual framework. In Proceedings of the 23rd Annual Conference, Belfast, UK, pp. 3-5.

[2] Molisa. (2023). Situation of occupational accidents in 2023. Ministry of Labor, War Invalids and Social Affairs, 2023. http://antoanlaodong.gov.vn/Images/files/ThôngbáoTNLĐ 2023.pdf.

[3] Meng, X., Chan, A.H., Lui, L.K., Fang, Y. (2021). Effects of individual and organizational factors on safety consciousness and safety citizenship behavior of construction workers: A comparative study between Hong Kong and Mainland China. Safety Science, 135: 105116. https://doi.org/10.1016/j.ssci.2020.105116

[4] Li, S., Wu, X., Wang, X., Hu, S. (2020). Relationship between social capital, safety competency, and safety behaviors of construction workers. Journal of Construction Engineering and Management, 146(6): 04020059. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001838

[5] 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

[6] Çakıt, E., Jan Olak, A., Murata, A., Karwowski, W., Alrehaili, O., Marek, T. (2019). Assessment of the perceived safety culture in the petrochemical industry in Japan: A cross-sectional study. PloS One, 14(12): e0226416. https://doi.org/10.1371/journal.pone.0226416

[7] Tappura, S., Jääskeläinen, A., Pirhonen, J. (2022). Creation of satisfactory safety culture by developing its key dimensions. Safety Science, 154: 105849. https://doi.org/10.1016/j.ssci.2022.105849

[8] Reiman, T., Rollenhagen, C. (2014). Does the concept of safety culture help or hinder systems thinking in safety? Accident Analysis & Prevention, 68: 5-15. https://doi.org/10.1016/j.aap.2013.10.033

[9] Hee, O.C., Ping, L.L. (2014). Organizational culture and safety performance in the manufacturing companies in Malaysia: A conceptual analysis. International Journal of Academic Research in Business and Social Sciences, 4(1): 99. https://doi.org/10.6007/IJARBSS/v4-i1/516

[10] Arezes, P.M., Sérgio Miguel, A. (2003). The role of safety culture in safety performance measurement. Measuring Business Excellence, 7(4): 20-28. https://doi.org/10.1108/13683040310509287

[11] Hofstede, G. (2001). Culture's Consequences: Comparing Values, Behaviors, Institutions and Organizations Across Nations. Sage Publications.

[12] Lee, T., Harrison, K. (2000). Assessing safety culture in nuclear power stations. Safety Science, 34(1-3): 61-97. https://doi.org/10.1016/S0925-7535(00)00007-2

[13] Gao, Y., Fan, Y., Wang, J., Li, X., Pei, J. (2019). The mediating role of safety management practices in process safety culture in the Chinese oil industry. Journal of Loss Prevention in the Process Industries, 57: 223-230. https://doi.org/10.1016/j.jlp.2018.11.017

[14] Hien, N.N., Kiet, N.T., Nguyen, A.T. (2024). The influence of safety culture on safety attitude, personnel error behavior, and safety citizenship behavior: Research in the Vietnam oil and gas industry. International Journal

of Safety and Security Engineering, 14(2): 399-409. https://doi.org/10.18280/ijsse.140208
[15] Booth, R.T., Lee, T.R. (1995). The role of human factors and safety culture in safety management. Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture, 209(5): 393-400. https://doi.org/10.1243/PIME_PROC_1995_209_098_02
[16] Choudhry, R.M., Fang, D., Mohamed, S. (2007). The nature of safety culture: A survey of the state-of-the-art. Safety Science, 45(10): 993-1012. https://doi.org/10.1016/j.ssci.2006.09.003
[17] Cooper, M.D. (2000). Towards a model of safety culture. Safety Science, 36(2): 111-136. https://doi.org/10.1016/S0925-7535(00)00035-7
[18] Parker, D., Lawrie, M., Hudson, P. (2006). A framework for understanding the development of organisational safety culture. Safety Science, 44(6): 551-562. https://doi.org/10.1016/j.ssci.2005.10.004
[19] Stemn, E., Bofinger, C., Cliff, D., Hassall, M.E. (2019). Examining the relationship between safety culture maturity and safety performance of the mining industry. Safety Science, 113: 345-355. https://doi.org/10.1016/j.ssci.2018.12.008
[20] Fleming, M. (2007). Developing safety culture measurement tools and techniques based on site audits rather than questionnaires. Final Project Report, Saint Marys University, 2007: 1-63.
[21] Leal Filho, W., Saari, U., Fedoruk, M., Iital, A., Moora, H., Klöga, M., Voronova, V. (2019). An overview of the problems posed by plastic products and the role of extended producer responsibility in Europe. Journal of Cleaner Production, 214: 550-558. https://doi.org/10.1016/j.jclepro.2018.12.256
[22] Mohamed, S., Ali, T.H., Tam, W.Y.V. (2009). National culture and safe work behaviour of construction workers in Pakistan. Safety Science, 47(1): 29-35. https://doi.org/10.1016/j.ssci.2008.01.003
[23] Wu, X., Liu, Q., Zhang, L., Skibniewski, M.J., Wang, Y. (2015). Prospective safety performance evaluation on construction sites. Accident Analysis & Prevention, 78: 58-72. https://doi.org/10.1016/j.aap.2015.02.003
[24] Daher, E. (2013). Safety culture maturity model: A process worth implementing? In SPE Americas E&P Health, Safety, Security and Environmental Conference, Galveston, Texas, USA, p. SPE-163756-MS. https://doi.org/10.2118/163756-MS
[25] Cooper, M.D., Collins, M., Bernard, R., Schwann, S., Knox, R.J. (2019). Criterion-related validity of the cultural web when assessing safety culture. Safety Science, 111: 49-66. https://doi.org/10.1016/j.ssci.2018.09.013
[26] Abeje, M., Luo, F. (2023). The influence of safety culture and climate on safety performance: Mediating role of employee engagement in manufacturing enterprises in Ethiopia. Sustainability, 15(14): 11274. https://doi.org/10.3390/su151411274
[27] Supardi, S., Chandrarin, G., Sunardi, S. (2021). Improving safety performance through safety leadership and safety behaviors. Italienisch, 11(2): 447-454.
[28] Neal, A., Griffin, M.A. (2006). A study of the lagged relationships among safety climate, safety motivation, safety behavior, and accidents at the individual and group levels. Journal of Applied Psychology, 91(4): 946. https://doi.org/10.1037/0021-9010.91.4.946
[29] Christian, M.S., Bradley, J.C., Wallace, J.C., Burke, M.J. (2009). Workplace safety: A meta-analysis of the roles of person and situation factors. Journal of Applied Psychology, 94(5): 1103-1127. https://doi.org/10.1037/a0016172
[30] Yang, J., Ye, G., Xiang, Q., Kim, M., Liu, Q., Yue, H. (2021). Insights into the mechanism of construction workers' unsafe behaviors from an individual perspective. Safety Science, 133: 105004. https://doi.org/10.1016/j.ssci.2020.105004
[31] Guo, B.H., Goh, Y.M., Wong, K.L.X. (2018). A system dynamics view of a behavior-based safety program in the construction industry. Safety Science, 104: 202-215. https://doi.org/10.1016/j.ssci.2018.01.014
[32] Guo, Z., Xiao, L., Van Toorn, C., Lai, Y., Seo, C. (2016). Promoting online learners' continuance intention: An integrated flow framework. Information & Management, 53(2): 279-295. https://doi.org/10.1016/j.im.2015.10.010
[33] Hiep, H.Y., Hien, N.N. (2023). Safety leadership, COVID-19 risk perception, and safety behavior: The moderator role of work pressure. International Journal of Safety and Security Engineering, 13(2): 255-266. https://doi.org/10.18280/ijsse.130208
[34] Hair, J.F., Hult, G.T.M., Ringle, C.M., Sarstedt, M., et al. (2021). An introduction to structural equation modeling. In Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook, pp. 1-29. https://doi.org/10.1007/978-3-030-80519-7_1
[35] Fornell, C., Larcker, D.F. (1981). Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research, 18(1): 39-50. https://doi.org/10.1177/002224378101800104
[36] Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. (2010). Multivariate Data Analysis: International Version. Upper Saddle River, NJ: Pearson Education.
[37] Gordon, R., Kirwan, B., Perrin, E. (2007). Measuring safety culture in a research and development centre: A comparison of two methods in the Air Traffic Management domain. Safety Science, 45(6): 669-695. https://doi.org/10.1016/j.ssci.2007.04.004
[38] Kirk, S., Parker, D., Claridge, T., Esmail, A., Marshall, M. (2007). Patient safety culture in primary care: Developing a theoretical framework for practical use. BMJ Quality & Safety, 16(4): 313-320. https://doi.org/10.1136/qshc.2006.018366
[39] Reiman, T., Pietikäinen, E. (2010). Indicators of safety culture-selection and utilization of leading safety performance indicators. Etdeweb.
[40] Tappin, D.C., Bentley, T.A., Ashby, L.E. (2015). An implementation evaluation of a qualitative culture assessment tool. Applied Ergonomics, 47: 84-92. https://doi.org/10.1016/j.apergo.2014.08.012
[41] Vinodkumar, M.N., Bhasi, M. (2010). Safety management practices and safety behaviour: Assessing the mediating role of safety knowledge and motivation. Accident Analysis & Prevention, 42(6): 2082-2093. https://doi.org/10.1016/j.aap.2010.06.021
[42] Goncalves Filho, A.P., Waterson, P. (2018). Maturity models and safety culture: A critical review. Safety Science, 105: 192-211. https://doi.org/10.1016/j.ssci.2018.02.017