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Factors Influencing Construction Workers' Unsafe Behavior: Evidence from Guangdong, China

Luo Ruxue*

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Abstract

Purpose: This study investigates the influencing factors and formation mechanisms of construction workers' unsafe behaviors in Guangdong Province, China. It aims to explore how safety climate, behavioral attitude, and risk perception affect unsafe behavior intentions and actual unsafe behavior on construction sites. **Research design, data and methodology:** A quantitative approach was adopted using a structured questionnaire based on validated instruments. Data were collected from 400 construction workers using multi-stage sampling across four companies in Guangdong. The questionnaire included five constructs measured on a 5-point Likert scale. Content validity was confirmed via IOC review by experts, and a pilot test confirmed reliability. Structural Equation Modeling (SEM) using AMOS was employed to assess model fit and test hypotheses. **Results:** The findings reveal that safety climate, behavioral attitude, and risk perception significantly predict unsafe behavior intention. Unsafe behavior intention, in turn, strongly influences actual unsafe behavior. Additionally, safety climate directly impacts actual unsafe behavior. The model showed good fit with all hypotheses supported. **Conclusions:** The study emphasizes the importance of fostering a positive safety climate, strengthening risk awareness, and shaping worker attitudes to reduce unsafe behavior. These insights offer a foundation for organizations to develop more focused and effective safety management practices in construction settings.

Keywords: Safety Climate, Behavioral Attitude, Risk Perception, Unsafe Behavior, Construction Workers

JEL Classification Code: I30, J28, J40, J80, L74

1. Introduction

In 2023, 648 construction-related fatalities were recorded across China, and unsafe acts accounted for 62 % of these incidents (Ministry of Emergency Management of the People's Republic of China [MEM], 2024). As China continues to advance economically and socially, the construction industry has emerged as a critical driver of both economic growth and rapid urbanization. However, the inherently high-risk nature of construction work exposes laborers to serious hazards, and unsafe behaviors remain the leading cause of site accidents. Recent empirical studies confirm that owners' safety management practices (Zhang et al., 2023) and psychosocial safety climate (Zhao & Li, 2024) strongly influence worker safety outcomes, underscoring the current urgency of the problem.

Despite growing awareness of this issue, existing research tends to focus on isolated factors influencing unsafe behavior, lacking a comprehensive and integrated framework that captures the multifaceted causes and mechanisms behind these behaviors. This highlights a critical research gap in understanding how various psychological, organizational, and perceptual elements interact to shape construction workers' unsafe behavioral patterns.

To address this gap, the present study aims to systematically examine the key factors influencing unsafe behavior among construction workers in Guangdong Province, China. It constructs an integrated theoretical framework grounded in the Theory of Planned Behavior (Ajzen, 1991), Social Cognitive Theory (Bandura, 1986), and Risk Perception Theory (Slovic, 2000) and supplements these perspectives with findings from prior empirical research. The proposed model incorporates five core variables: safety climate, behavioral attitudes, risk perception, unsafe behavior intention, and actual unsafe behavior. Using data from 400 valid questionnaire responses,

1*Luo Ruxue, PhD.ITM, School of Business and Advanced Technology Management, Assumption University, Thailand. Email: luoruxue@zjkju.edu.cn

the study employs Structural Equation Modeling (SEM) to test the hypothesized relationships and assess the model's fit (Hair et al., 2010).

The findings reveal that unsafe behavior intentions significantly predict actual unsafe behavior (Hofmann & Stetzer, 1996). Furthermore, safety climate, behavioral attitudes, and risk perception are key antecedents of unsafe behavior intentions. Specifically, a positive safety climate significantly reduces unsafe intentions (Zohar, 2000), favorable behavioral attitudes are linked to lower unsafe behavior intentions (Ajzen, 1991), and accurate risk perception helps mitigate these intentions (Slovic, 2000).

This study contributes to the literature by integrating multiple theoretical perspectives into a cohesive framework, thereby offering a deeper understanding of the complex mechanisms behind unsafe behaviors. The empirical validation of this model provides robust evidence to guide construction companies in identifying risk factors and formulating effective safety interventions.

From a practical standpoint, the results offer scientific insights that can help construction enterprises develop targeted management strategies, reduce the frequency of unsafe behaviors, safeguard workers' health and safety, and ultimately promote the sustainable development of the construction industry.

For future research, the scope can be broadened to explore additional influencing factors such as organizational culture, leadership style, and occupational stress. A longitudinal research design is also recommended to capture the evolving nature of unsafe behaviors and their dynamic relationships with associated variables over time, offering forward-looking guidance for safety management in construction settings.

2. Literature Review

2.1 Unsafe behaviors

Unsafe behaviors in the construction industry refer to worker actions that violate established safety procedures, thereby increasing the likelihood of accidents, injuries, and fatalities. These behaviors often include neglecting to use personal protective equipment (PPE), bypassing required safety checks, and engaging in high-risk tasks without adequate precautions. Such behaviors not only endanger the individuals involved but also pose risks to coworkers, disrupt project workflows, and result in economic and reputational losses for organizations.

Recent studies emphasize that unsafe behaviors are influenced by a complex interplay of individual, psychological, and organizational factors. For instance, Kuang et al. (2025) found that cognitive biases such as overconfidence and familiarity with high-risk tasks can distort risk perception and increase the likelihood of unsafe actions, particularly among younger and less experienced workers. In addition, Meng et al. (2021) provided a systematic review of literature identifying key drivers of unsafe behavior, including insufficient safety training, weak safety culture, and high work pressure. These factors impair judgment and decision-making, leading to greater incidence of risk-prone behavior on construction sites.

Addressing unsafe behavior requires a comprehensive, multi-layered approach. Effective strategies include enhancing safety training programs to improve hazard recognition, implementing clear and enforceable safety policies, conducting regular safety audits, and fostering a positive safety culture that encourages worker engagement and peer accountability. By targeting both behavioral and systemic causes, construction organizations can significantly reduce unsafe practices and enhance workplace safety.

Given the central role that unsafe behaviors play in contributing to construction site incidents, this study positions them as the dependent variable. The objective is to examine the key antecedents influencing these behaviors, which will inform the development of targeted hypotheses in the following sections.

2.2 Safety Climate and Unsafe Behavioral Intention

Safety climate (SC) refers to employees' shared perceptions regarding the importance their organization places on safety, encompassing values, norms, and practices related to workplace safety (Zohar, 2000). In the construction industry, where occupational hazards are prevalent, safety climate has emerged as a critical factor influencing worker behavior. A robust safety climate indicates that safety is treated as a core organizational value, manifested through visible management commitment, adequate resource allocation, and consistent enforcement of safety protocols (Hofmann & Stetzer, 1996). Such a climate fosters a collective mindset that discourages unsafe actions and promotes adherence to safe practices.

Recent empirical studies have reinforced the significance of safety climate in shaping safety behaviors. For instance, Gao et al. (2022) found that a positive safety climate significantly reduces construction workers' intentions to engage in unsafe behaviors. Similarly, Zhao and Li (2024) demonstrated that safety climate influences safety behavior both directly and indirectly by enhancing psychological resilience and reducing safety-related stress.

These findings suggest that cultivating a strong safety climate is an effective strategy for preventing unsafe behaviors among construction workers. When safety is prioritized and visibly supported by leadership, workers are

more likely to internalize safe work practices and avoid risk-taking behaviors. Based on the above theoretical and empirical insights, the following hypothesis is proposed:
H1: There is a significant negative relationship between Safety Climate (SC) and Unsafe Behavior Intention (UBI).

2.3 Behavioral Attitude and Unsafe Behavioral Intention

Behavioral attitude (BA) refers to an individual's positive or negative evaluation of performing a particular behavior (Ajzen, 1991). In the construction industry, workers' attitudes toward safety protocols significantly influence their intentions to engage in safe or unsafe behaviors. A positive safety attitude implies that workers value adherence to safety rules and recognize their effectiveness in mitigating risks and preventing accidents.

The Theory of Planned Behavior (TPB) posits that behavioral attitudes are key predictors of behavioral intentions (Ajzen, 1991). Empirical studies have supported this theory within the construction context. For instance, a study by Li et al. (2022) found that construction workers with positive safety attitudes were less likely to intend to engage in unsafe behaviors. Similarly, Zhang and Wang (2022) demonstrated that safety attitudes significantly mediated the relationship between organizational safety climate and workers' unsafe behavior intentions.

These findings underscore the importance of fostering positive safety attitudes among construction workers to reduce unsafe behavioral intentions. By enhancing workers' perceptions of the value and effectiveness of safety practices, organizations can proactively mitigate the likelihood of unsafe behaviors on construction sites. Based on the theoretical framework and empirical evidence, the following hypothesis is proposed:
H2: There is a significant negative relationship between Behavioral Attitude (BA) and Unsafe Behavior Intention (UBI).

2.4 Risk Perception and Unsafe Behavioral Intention

Risk perception (RP) refers to an individual's subjective judgment regarding the likelihood and severity of potential hazards in their environment (Slovic, 2000). In the construction industry, accurate risk perception is crucial, as it influences workers' decisions to engage in safe or unsafe behaviors. When workers effectively recognize and assess potential risks, they are more likely to adopt precautionary measures and avoid hazardous actions.

Empirical studies have demonstrated the significant role of risk perception in shaping safety behaviors. For instance, Wang and Xu (2022) found that higher levels of risk perception among Chinese frontline construction workers were associated with increased safety compliance and participation. Their study highlighted that risk perception, influenced by factors such as social support and job satisfaction, can enhance workers' commitment to safety protocols.

Similarly, a study by Xiang et al. (2023) revealed that failures in risk perception, along with attention and hazard recognition failures, significantly contributed to unsafe behaviors among construction workers. Using eye-tracking and thinking-aloud methods, the researchers identified that inadequate risk assessment led to a higher propensity for engaging in unsafe actions.

These findings underscore the importance of enhancing risk perception through targeted interventions, such as comprehensive safety training and fostering a strong safety culture. By improving workers' ability to accurately assess risks, organizations can reduce the likelihood of unsafe behaviors on construction sites. Based on the theoretical framework and empirical evidence, the following hypothesis is proposed:
H3: There is a significant negative relationship between Risk Perception (RP) and Unsafe Behavior Intention (UBI).

2.5 Unsafe Behavior Intention and Unsafe Behavior

Unsafe Behavior Intention (UBI) refers to a worker's deliberate plan or inclination to engage in behaviors that deviate from established safety protocols. It serves as a critical link between internal psychological factors and observable actions on construction sites. According to the Theory of Planned Behavior (TPB), behavioral intention is the immediate antecedent of actual behavior (Ajzen, 1991). This theory posits that when workers harbor strong intentions to act unsafely, the likelihood of them executing such behaviors increases correspondingly.

Empirical studies have substantiated this theoretical framework. For instance, Hofmann and Stetzer (1996) identified a significant positive correlation between unsafe behavioral intentions and actual unsafe behaviors among workers. This relationship is particularly pronounced in the construction industry, where dynamic and hazardous environments can amplify the translation of intentions into actions.

Further research by Yao et al. (2022) examined the impact of organizational factors on unsafe behavior intentions. Their study revealed that ineffective subcontracting management practices could heighten workers' intentions to engage in unsafe behaviors, which, in turn, increased the incidence of actual unsafe acts on construction sites. This finding underscores the influence of organizational context on the intention-behavior nexus.

Additionally, a study by Zhang et al. (2023) explored the mediating role of safety attitudes in the relationship between safety climate and unsafe behavior intentions. They found that a positive safety climate fosters favorable safety attitudes, which subsequently reduce unsafe behavior intentions and actual unsafe behaviors. This highlights the importance of cultivating a robust safety culture to mitigate unsafe practices.

These studies collectively affirm that unsafe behavior intentions are a significant predictor of actual unsafe behaviors in the construction industry. Understanding and addressing the factors that influence these intentions are crucial for developing effective safety interventions. Based on the theoretical framework and empirical evidence, the following hypothesis is proposed:

H4: There is a significant positive relationship between Unsafe Behavior Intention (UBI) and Unsafe Behavior (UB).

2.6 Safety Climate and Unsafe Behavior

Safety climate (SC) refers to workers' shared perceptions of the importance their organization places on safety, encompassing management commitment, safety policies, and procedures. A positive safety climate not only influences workers' intentions regarding safety behaviors but may also have a direct effect on actual unsafe behaviors (Zohar, 2000). In the construction industry, where environments are dynamic and hazardous, the role of safety climate is particularly critical.

Recent studies have demonstrated a significant negative correlation between safety climate and unsafe behaviors among construction workers. For instance, Tabanfar et al. (2021) found that higher safety climate scores were associated with reduced unsafe behaviors in the construction industry. Similarly, research by Wang and Xu (2022) indicated that a positive safety climate directly reduces workers' unsafe behaviors by reinforcing safety norms and providing a supportive environment. Moreover, safety climate indirectly affects unsafe behaviors by enhancing workers' risk perception and safety attitudes.

These findings underscore the importance of fostering a robust safety climate within construction organizations. By prioritizing safety through effective management practices, clear communication, and comprehensive training, organizations can directly mitigate unsafe behaviors and promote a culture of safety. Based on the theoretical framework and empirical evidence, the following hypothesis is proposed:

H5: There is a significant negative relationship between Safety Climate (SC) and Unsafe Behavior (UB).

Through a comprehensive review of the literature and theoretical foundations, this study systematically explores the relationships among safety climate, behavioral attitudes, risk perception, unsafe behavior intention, and actual unsafe behavior. The five proposed hypotheses span multiple levels, from individual psychological factors to observable workplace behaviors aiming to holistically uncover the underlying mechanisms that contribute to unsafe behaviors among construction workers.

3. Research Methods and Materials

3.1 Research Framework

This study focuses on understanding what causes unsafe behavior among construction workers in Guangdong, China. It aims to find out what factors influence these behaviors and how they are connected. The research framework is based on three well-known theories: the Theory of Planned Behavior (Ajzen, 1991), Social Cognitive Theory (Bandura, 1986), and Risk Perception Theory (Slovic, 2000). It includes five main factors: safety climate, behavioral attitude, risk perception, unsafe behavior intention, and actual unsafe behavior.

The study draws on prior research to support its conceptual framework. Specifically, it uses the Theory of Planned Behavior to explain how attitudes, perceived norms, and behavioral intentions shape unsafe actions (Sun et al., 2024). It also incorporates Social Cognitive Theory to reflect the role of group norms and observational learning in shaping unsafe intentions (Zhang & Ma, 2024). Additionally, Risk Perception Theory is referenced to emphasize how workers' cognitive assessments of risk influence their intentions to behave unsafely (Shi et al., 2021). These studies collectively guide the identification of key influencing variables and their expected pathways.

Then, based on the theories and past research, several research hypotheses are developed. These hypotheses suggest that the five factors are related either directly or indirectly, as shown in Figure 1.

Data were collected through questionnaires given to construction workers. The relationships among the five factors were analyzed using Structural Equation Modeling (SEM). This method helped check whether the proposed model fits the data and whether the hypotheses are supported. The goal is to better understand why unsafe behaviors happen and to give useful ideas for improving safety at construction sites (Hofmann & Stetzer, 1996; Zohar, 2000).

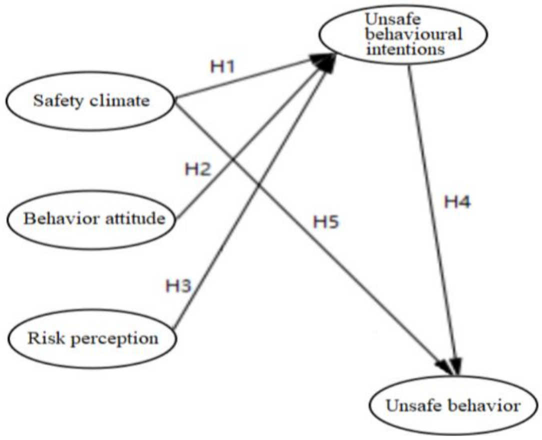

Figure 1: Conceptual Framework

3.2 Research Methodology

This study adopted a quantitative research approach and collected data online using the Questionnaire Star platform through WeChat. The questionnaire consisted of three sections: (1) screening questions to ensure participants met the inclusion criteria, (2) demographic information, and (3) measurement items for the five research variables, each assessed using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Before the full-scale distribution, the questionnaire underwent two key validation steps. First, three field experts reviewed the items to evaluate content validity using the Item-Objective Congruence (IOC) index. All items achieved IOC values above the acceptable threshold of 0.50, indicating satisfactory content validity (Rovinelli & Hambleton, 1977). Second, a pilot test was conducted with a sample of 40 construction workers from the target population. The pilot data were analyzed for internal consistency reliability, with Cronbach's alpha values exceeding 0.70 for all constructs, thus meeting the commonly accepted reliability standard (Nunnally & Bernstein, 1994).

After confirming both content validity and internal consistency, the finalized questionnaire was distributed, resulting in 400 valid responses. The collected data were analyzed using SPSS and AMOS software. The analysis involved Confirmatory Factor Analysis (CFA) to test the measurement model's convergent and discriminant validity, followed by Structural Equation Modeling (SEM) to examine the hypothesized relationships between the constructs.

To reduce the risk of common method bias, the survey was anonymous, and item ordering was randomized. Harman's single-factor test was also conducted, and the results indicated that no single factor accounted for the majority of the variance, suggesting that common method bias was not a serious concern. During the CFA and SEM procedures, modification indices were reviewed, and only theoretically justified adjustments were applied to improve model fit without compromising the theoretical integrity of the constructs.

Ethical approval for the study was obtained from the institutional review board of the affiliated university. All participants were informed about the purpose of the study and voluntarily provided their consent prior to completing the questionnaire.

These procedures ensured that the measurement tools were both statistically sound and conceptually aligned with the research objectives.

3.3 Population and Sample Size

This study focuses on construction workers in Guangdong Province, China, aiming to investigate the key factors influencing unsafe behaviors and their underlying mechanisms. As one of China's most active construction regions, Guangdong is home to a diverse workforce spanning various skill levels, job types, educational backgrounds, and regional origins. This diversity provides a robust basis for studying both common patterns and specific characteristics of unsafe behaviors in the industry.

To ensure data quality and representativeness, a multi-stage sampling technique was adopted. In the first stage, purposive sampling was used to select four representative construction companies located in different parts of the province. These companies are located in different parts of the province and vary in size, project types, and safety management practices, allowing for a diverse and comprehensive sample.

In the second stage, stratified random sampling was conducted within each company. Workers were stratified by key characteristics such as job position, type of work, work experience, and education level. Random samples were then drawn from each stratum to ensure balanced representation and reduce sampling bias. This method effectively combines the targeted precision of purposive sampling with the statistical rigor of stratified random sampling, resulting in a highly representative and reliable dataset.

A total of 400 valid questionnaires were collected from a combined population of 9,500 workers across the four selected companies. The proportional sample sizes for each company are presented in Table 1. This sample size meets the minimum requirement for structural equation modeling (SEM) analysis, as recommended by Hair et al. (2010), and enhances the robustness and generalizability of the study findings.

This well-structured sampling strategy not only captures the breadth and depth of unsafe behaviors among construction workers in Guangdong but also provides strong empirical support for formulating practical safety management interventions.

Table 1: Sample Units and Sample Size

Humanities	Population Size	Proportional Sample Size
Guangdong Construction Group	5,000	210
Guangdong Xiangshun Construction Company	1,200	50
Guangzhou Yuexiu Construction Company	2,500	105
Zhanjiang Construction Group Corporation	800	35
Total	**9,500**	**400**

Note: Constructed by the Author

4. Results and Discussion

4.1 Demographic Information

A total of 400 valid responses were collected for this study, capturing a diverse group of construction workers in Guangdong Province. The sample reflects variation across gender, age, educational attainment, and marital status.

As shown in Table 2, the majority of respondents were male and between 26 and 30 years old, suggesting that the construction workforce is predominantly young and male. Educational backgrounds were fairly balanced, with a significant portion having completed high school or tertiary education. Notably, one-fifth of the workers held a bachelor's degree or higher, indicating a mix of skill and knowledge levels within the industry. In terms of marital status, a large proportion of the respondents were married, which may have implications for job stability, risk perception, and behavioral intentions. These demographic characteristics provide useful context for interpreting the behavioral trends and safety attitudes.

Table 2: Demographic Information

Demographic and General Data (N=400)		Frequency	Percentage
Gender	Male	240	60%
	Female	160	40%
Age	25 years old and below	120	30%
	26-30 years old	160	40%
	31 to 40 years old	80	20%
	41 and above	40	10%
Educational Level	Junior Secondary or below	80	20%
	High School (Secondary)	120	30%
	Tertiary	120	30%
	Bachelor's degree or above	80	20%
Marital Status	Married	280	70%
	Unmarried	120	30%

Note: Constructed by the Author

4.2 Confirmatory Factor Analysis (CFA)

Confirmatory Factor Analysis (CFA) was conducted to assess the reliability and validity of the measurement model. Five latent variables, Safety Climate (SC), Behavioral Attitude (BA), Risk Perception (RP), Unsafe Behavior Intention (UBI), and Unsafe Behavior (UB) were included, with each construct measured by 4 to 5 items using a five-point Likert scale.

Internal consistency reliability was first evaluated using Cronbach's Alpha and Composite Reliability (CR). All constructs reported Cronbach's Alpha values above the recommended threshold of 0.70, indicating acceptable reliability (Nunnally & Bernstein, 1994). Similarly, CR values for all variables exceeded 0.70, confirming internal consistency (Hair et al., 2010).

Convergent validity was assessed through factor loadings and Average Variance Extracted (AVE). Standardized factor loadings for all items ranged from 0.68 to 0.85, exceeding the minimum recommended threshold of 0.50 (Hair et al., 2010), indicating that individual items effectively measured their respective constructs. Furthermore, all AVE values met or surpassed the 0.50 benchmark, demonstrating that the constructs captured more variance from their indicators than from measurement error (Fornell & Larcker, 1981).

These results confirm that the measurement model possesses strong reliability and convergent validity, supporting the use of the observed variables in subsequent Structural Equation Modeling (SEM) analyses.

Table 3: Confirmatory Factor Analysis (CFA), Composite Reliability (CR), and Average Variance Extracted (AVE) Results

Variable	Source of Questionnaire (Measurement Indicator)	No. of Item	Cronbach's Alpha	Factor Loading	CR	AVE
Safety Climate (SC)	Huang et al. (2006)	5	0.91	0.74-0.82	0.91	0.62
Behavior Attitude (BA)	Li et al. (2022)	5	0.89	0.68-0.81	0.89	0.58
Risk Perception (RP)	Liu et al. (2021)	5	0.87	0.68-0.79	0.87	0.55
Unsafe Behavior Intention (UBI)	Li et al. (2022)	4	0.85	0.71-0.82	0.85	0.59
Unsafe Behavior (UB)	Choudhry and Fang (2008)	4	0.88	0.78-0.85	0.88	0.64

Note: CR = Composite Reliability, AVE = Average Variance Extracted

In addition, to comprehensively assess the measurement model, the researcher employed a variety of model fit indices, including CMIN/DF, GFI, AGFI, NFI, CFI, TLI, and RMSEA. These indices evaluate model fit from different perspectives and are widely used in structural equation modeling. Specifically, a CMIN/DF value below 5, GFI, AGFI, NFI, CFI, and TLI values at or above recommended thresholds (typically 0.90), and an RMSEA value below 0.08 are generally considered indicators of a good model fit (Hu & Bentler, 1999). These criteria provide a robust basis for determining whether the measurement model adequately represents the data.

Before proceeding with hypothesis testing, discriminant validity was assessed to ensure that the constructs in the model are empirically distinct from one another. Two established methods were employed: the Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio.

According to the Fornell-Larcker criterion, the square root of the Average Variance Extracted (AVE) for each construct should be greater than its correlations with other constructs (Fornell & Larcker, 1981). As shown in Table 4, this condition was satisfied for all constructs, indicating that each latent variable shares more variance with its own indicators than with those of other constructs.

Additionally, the HTMT ratio was used as a complementary method to confirm discriminant validity. All HTMT values were found to be below the commonly accepted threshold of 0.85 (Henseler et al., 2015), further supporting the distinction between the constructs.

These results confirm that the model meets the requirements for discriminant validity, ensuring that the variables are statistically independent and appropriate for further structural analysis.

Table 4: Discriminant Validity

Variable	Factor Correlations				
	SC	BA	RP	UBI	UB
SC	**0.72**				
BA	0.62	**0.73**			
RP	0.58	0.60	**0.71**		
UBI	0.55	0.57	0.59	**0.68**	
UB	0.50	0.52	0.54	0.63	**0.65**

Note: The diagonally listed value is the AVE square roots of the variables

4.3 Structural Equation Model (SEM)

Structural Equation Modeling (SEM) is a statistical technique used to examine complex relationships among multiple variables, incorporating both model fit and the strength of inter-variable effects (Byrne, 2016).

To assess model fit, several commonly used fit indices were examined, as shown in Table 5. The results indicate that all indices fall within acceptable thresholds. Specifically, the CMIN/DF ratio was 2.85, well below the upper limit of 5. The GFI, AGFI, NFI, CFI, and TLI values all exceeded their respective minimum acceptable values (ranging from 0.80 to 0.90), indicating a strong fit between the model and the observed data. The RMSEA value was 0.06, below the recommended cutoff of 0.08, further supporting model adequacy (Hu & Bentler, 1999).

Additionally, the analysis of path coefficients revealed that both direct and indirect effects between the latent variables were statistically significant. These findings provide empirical support for the proposed research hypotheses and confirm the theoretical relationships outlined in the conceptual model (Kline, 2015).

Table 5: Goodness of Fit for Structural Equation Modeling

Index	Criterion	Statistical Value
CMIN/DF	< 5 (Al-Mamary & Shamsuddin, 2015; Awang, 2012)	2.85
GFI	≥ 0.85 (Sica & Ghisi, 2007)	0.92
AGFI	≥ 0.80 (Sica & Ghisi, 2007)	0.89
NFI	≥ 0.80 (Wu & Wang, 2006)	0.91
CFI	≥ 0.80 (Wu & Wang, 2006)	0.94
TLI	≥ 0.80 (Wu & Wang, 2006)	0.93
RMSEA	< 0.08 (Hu & Bentler, 1999)	0.06

Note: CMIN/DF = The ratio of the chi-square value to degree of freedom, GFI = goodness-of-fit index, AGFI = adjusted goodness-of-fit index, NFI = normalized fit index, CFI = comparative fit index, TLI = Tucker Lewis index and RMSEA = root mean square error of approximation

4.4 Research Hypothesis Testing Result

The structural model was tested using SEM, and the results are presented in Table 6. All five hypotheses were statistically supported, indicating significant relationships among the variables. Specifically, Safety Climate (SC), Behavioral Attitude (BA), and Risk Perception (RP) significantly influenced Unsafe Behavior Intention (UBI), while UBI had a strong effect on Actual Unsafe Behavior (UB). Additionally, SC was found to have a direct effect on UB, supporting both mediated and direct paths.

The model explained 52% of the variance ($R^2 = 0.52$) in Unsafe Behavior Intention (UBI) and 63% of the variance ($R^2 = 0.63$) in Actual Unsafe Behavior (UB). These values indicate that the model has strong explanatory power in predicting unsafe behavioral outcomes among construction workers.

The findings are consistent with the theories and empirical studies referenced earlier, particularly the Theory of Planned Behavior (Ajzen, 1991), Risk Perception Theory (Slovic, 2000), and studies on safety climate and unsafe behaviors (Hofmann & Stetzer, 1996; Zohar, 2000).

Table 6: Hypothesis Testing Result

Hypothesis	Standardized path coefficients (β)	t-value	Test Result
H1: SC → UBI	0.281	4.954*	Supported
H2: BA → UBI	0.690	4.622*	Supported

Hypothesis	Standardized path coefficients (β)	t-value	Test Result
H3: RP → UBI	0.450	4.326*	Supported
H4: UBI → UB	0.640	4.161*	Supported
H5: SC → UB	0.278	4.503*	Supported

Note: *=p-value<0.05

H1: The significant effect of safety climate on unsafe behavior intention (β = 0.281) supports recent findings by Gao et al. (2022), who demonstrated that a positive safety climate significantly lowers the likelihood of unsafe behavior intentions among construction workers. This confirms that organizational emphasis on safety promotes cautious behavior at the intention level.

H2: Behavioral attitude showed the strongest influence on unsafe behavior intention (β = 0.690), consistent with Zhang and Wang (2022). Their study emphasized that positive safety attitudes significantly mediate the relationship between safety climate and behavioral intentions, reinforcing the importance of attitude-based safety interventions.

H3: The significant impact of risk perception on unsafe behavior intention (β = 0.450) aligns with the work of Wang and Xu (2022), who found that heightened risk perception, shaped by factors like job satisfaction and social support, correlates with increased safety compliance. This study reaffirms that accurate risk appraisal plays a critical role in minimizing unsafe intentions.

H4: The direct and strong relationship between UBI and actual unsafe behavior (β = 0.640) supports findings by Xiang et al. (2023), who used eye-tracking data to demonstrate that intention-related failures in hazard recognition directly contribute to unsafe actions. This highlights the need to manage behavioral intentions early in the safety management process.

H5: The direct effect of safety climate on actual unsafe behavior (β = 0.278) is in line with Tabanfar et al. (2021), who reported that multiple dimensions of safety climate significantly reduce the likelihood of unsafe practices on site. This suggests that the influence of safety climate extends beyond intention and shapes real-time behavior directly.

5. Conclusions and Recommendation

5.1 Conclusions

This study systematically investigated the factors influencing unsafe behaviors among construction workers in Guangdong Province, China. By integrating the Theory of Planned Behavior, Social Cognitive Theory, and Risk Perception Theory, a comprehensive structural model was developed and empirically validated using SEM. The findings contribute to a deeper understanding of how individual psychological factors and organizational safety environments interact to shape both unsafe behavioral intentions and actual unsafe behaviors.

The results confirm that safety climate plays a dual role, significantly influencing both intentions and actual behaviors. This finding aligns with Gao et al. (2022) and Tabanfar et al. (2021), who emphasized that a strong safety climate not only discourages unsafe intentions but also fosters real-time safety compliance. The standardized path coefficients indicate that safety climate had a moderate effect on unsafe behavior intention (β = 0.281) and a direct effect on actual unsafe behavior (β = 0.278), suggesting that safety climate interventions can yield tangible behavioral improvements both at the attitudinal and behavioral level. This reinforces the argument that creating a positive, management-supported safety culture is central to reducing workplace risk in the construction industry.

Behavioral attitude emerged as the most influential predictor of unsafe behavior intention, underscoring the central claim of the Theory of Planned Behavior (Ajzen, 1991). With the strongest path coefficient (β = 0.690), this variable demonstrates a high level of explanatory power for behavioral intentions, indicating that interventions targeting workers' safety attitudes may yield the most substantial reduction in unsafe behavior intention. The strong relationship found between workers' attitudes and their behavioral intentions echoes the findings of Zhang and Wang (2022), suggesting that safety interventions that target workers' internal beliefs and values may be more effective than those focused solely on external enforcement.

Similarly, risk perception was found to significantly affect unsafe behavior intention, which corroborates the results of Wang and Xu (2022) and Xiang et al. (2023). These studies highlighted how accurate hazard identification and risk evaluation reduce risk-taking intentions. The standardized effect (β = 0.450) shows that risk perception has a moderate but meaningful impact on intention, emphasizing the importance of enhancing workers' ability to recognize job hazards through tailored risk-awareness training.

The study also confirms a strong link between unsafe behavior intention and actual unsafe behavior, reinforcing the principle that intention is the most immediate predictor of action, as shown by Xiang et al. (2023). The high coefficient (β = 0.640) confirms that targeting intentions early through psychological or behavioral interventions is likely to significantly reduce the occurrence of actual unsafe practices. This supports the importance of early-stage interventions that target unsafe intentions before they manifest into observable workplace behavior.

This study contributes theoretically by integrating established behavioral and cognitive frameworks into a unified model, offering a comprehensive explanation of unsafe behavior formation. It extends earlier findings by empirically validating a multi-variable framework connecting cognition, intention, and behavior. Furthermore, the cross-level influence of safety climate reinforces the value of integrating individual- and organizational-level factors, as highlighted in Zhao and Li (2024).

From a practical standpoint, the findings provide actionable insights for construction companies seeking to reduce workplace incidents. Companies should prioritize the development of a positive safety climate through consistent managerial support, visible commitment to safety protocols, and effective communication. At the same time, behavior-based interventions should focus on improving workers' safety attitudes and enhancing their ability to perceive risks accurately. Given the magnitude of these relationships, allocating more resources to attitude-based programs and hazard-awareness training is justified, as these factors exhibit substantial explanatory power over workers' behavioral choices. As suggested by Zhang and Wang (2022), safety training programs should go beyond technical instructions to address cognitive and motivational aspects of behavior. Tailored strategies that target workers' psychological drivers can effectively minimize unsafe intentions and, by extension, reduce actual unsafe behaviors.

This study not only supports and extends current knowledge in the field but also offers empirically grounded guidance for developing more effective, psychologically informed safety management systems in construction environments.

5.2 Recommendations

Based on the findings of this study, several targeted recommendations are proposed to enhance safety management and reduce unsafe behaviors among construction workers. These strategies are organized across four key levels: enterprise, managerial, training and education, and technology and innovation.

1. Enterprise-Level Recommendations

Construction companies should elevate safety management to a strategic priority and embed it fully into operational practices. This begins with increasing investment in safety-related resources, including advanced protective equipment, smart monitoring systems, and regular training programs. For instance, adopting intelligent safety surveillance technologies and high-performance personal protective equipment (PPE) can significantly reduce risks on-site. These actions directly address the finding that safety climate has both a direct ($\beta = 0.278$) and indirect ($\beta = 0.281$ via intention) effect on unsafe behavior (H1, H5), reinforcing the need for top-level commitment to fostering a strong safety climate.

A comprehensive safety management system should be established, clearly defining the roles and responsibilities of each department and employee. Moreover, fostering a strong safety culture is essential. This includes leadership modeling safe behavior, ongoing safety campaigns, and values-driven training that encourages all workers to internalize safety as a core organizational value. Such cultural reinforcement supports the study's conclusion that safety climate influences both intention and behavior and is thus a critical organizational-level variable.

2. Managerial-Level Recommendations

At the managerial level, safety supervision must be proactive and consistent. Regular on-site inspections by qualified personnel should be conducted to promptly identify and mitigate potential hazards. Additionally, companies should implement a robust safety performance evaluation system, integrating safety compliance into individual performance appraisals. Rewarding safe behaviors and addressing violations through corrective feedback can strengthen motivation for compliance. This recommendation addresses the impact of behavioral attitudes (H2: $\beta = 0.690$) on unsafe behavior intention, emphasizing the role of managerial reinforcement in shaping workers' safety-related beliefs and actions.

Equally important is communication. Managers should maintain open dialogue with frontline workers to better understand the practical safety challenges they face and collaboratively identify effective solutions. This participatory approach enhances worker engagement in safety management. This aligns with the psychological mechanisms outlined in the Theory of Planned Behavior and Social Cognitive Theory, which highlight the importance of social interaction and self-efficacy in shaping intention.

3. Training and Education

Safety training should be conducted regularly and tailored to different roles and job functions. Training content should include safety regulations, operating procedures, case-based accident analysis, and emergency response strategies. A blended approach, combining classroom instruction, field demonstrations, simulations, and interactive discussions will maximize retention and application of knowledge. This responds to findings related to risk perception (H3: $\beta = 0.450$), which suggest that improving workers' ability to accurately identify and evaluate risks reduces unsafe intentions.

To reinforce learning, companies can organize initiatives such as safety quizzes, hands-on skill competitions, and certification assessments. These activities not only enhance skills but also cultivate a culture of continuous safety learning among workers. By influencing attitudes and increasing perceived behavioral control, these educational efforts further address unsafe intentions, as supported by H2 and H3.

4. Technology and Innovation

Technological innovation offers transformative potential for safety management. Companies are encouraged to adopt Internet of Things (IoT) solutions for real-time hazard monitoring, utilize big data analytics to identify high-risk zones and behavior patterns, and apply virtual reality (VR) for immersive safety training simulations. These technologies can significantly improve hazard detection and prevention. This reflects the study's emphasis on the predictive strength of behavioral intention on actual behavior (H4: $\beta = 0.640$) and demonstrates how modern tools can intervene early in the behavioral process.

In addition, fostering a culture of internal innovation is key. Workers should be encouraged to propose practical safety solutions, and those that prove effective should be formally recognized and scaled up. Supporting bottom-up innovation can accelerate continuous improvement in safety practices. This recommendation promotes stronger worker engagement and ownership, which aligns with Social Cognitive Theory and the need to positively influence both risk perception and behavioral attitude.

By addressing safety management from these four dimensions, construction companies can build a more resilient and proactive safety system, one that not only responds to risk but anticipates and prevents it. Each recommendation is grounded in the study's empirical results and supported hypotheses, offering clear guidance for reducing unsafe intentions and actual unsafe behaviors among construction workers.

5.3 Limitation and Further Study

While this study offers valuable insights into the factors influencing unsafe behaviors among construction workers in Guangdong Province, it has several limitations. The sample was limited to four construction companies in a single region, which may restrict the generalizability of the findings across China's diverse construction sector. Additionally, the reliance on self-reported questionnaire data introduces the possibility of social desirability bias, potentially affecting the accuracy of responses. The study also did not account for individual differences such as personality traits, work experience, or psychological factors, which may play a significant role in shaping unsafe behaviors.

Future research should broaden the scope by including a larger and more diverse sample across multiple regions and project types to enhance representativeness. A mixed-method approach that incorporates interviews, on-site observations, and behavioral audits could enrich the data and minimize self-reporting bias. Moreover, integrating individual-level variables such as cognitive style, emotional state, and experience into the model would offer a more comprehensive understanding of the behavioral mechanisms involved. Finally, future studies could benefit from the application of big data analytics and longitudinal case studies to uncover dynamic patterns and predictive indicators of unsafe behavior over time. These enhancements would contribute to a deeper and more actionable body of knowledge for improving construction safety management.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Al-Mamary, Y. H., & Shamsuddin, A. (2015). Testing of the technology acceptance model in context of Yemen. *Mediterranean Journal of Social Sciences, 6*(4), 268. https://doi.org/10.5901/mjss.2015.v6n4s1p268

Awang, Z. (2012). *Research methodology and data analysis* (2nd ed.). UiTM Press.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall.

Byrne, B. M. (2016). *Structural equation modeling with AMOS: Basic concepts, applications, and programming* (3rd ed.). Routledge.

Choudhry, R. M., & Fang, D. (2008). Why operatives engage in unsafe work behavior: Investigating factors on construction sites. *Safety Science, 46*(4), 566-584. https://doi.org/10.1016/j.ssci.2006.08.003

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

Gao, Y., González, V. A., Yiu, T. W., Cabrera-Guerrero, G., & Deng, R. (2022). Predicting construction workers' intentions to engage in unsafe behaviours using machine learning algorithms and taxonomy of personality. *Buildings, 12*(6), 841. https://doi.org/10.3390/buildings12060841

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Pearson.

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science, 43*(1), 115-135. https://doi.org/10.1007/s11747-014-0403-8

Hofmann, D. A., & Stetzer, A. (1996). A cross-level investigation of factors influencing unsafe behaviors and accidents. *Personnel Psychology, 49*(2), 307-339. https://doi.org/10.1111/j.1744-6570.1996.tb01827.x

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1-55. https://doi.org/10.1080/10705519909540118

Huang, Y.-H., Ho, M., Smith, G. S., & Chen, P. Y. (2006). Safety climate and self-reported injury: Assessing the mediating role of employee safety control. *Accident Analysis & Prevention, 38*(3), 425-433. https://doi.org/10.1016/j.aap.2005.11.007

Kline, R. B. (2015). *Principles and practice of structural equation modeling* (4th ed.). Guilford Press.

Kuang, Y., Chen, X., Yang, H., Zhang, H., & Wong, C. U. I. (2025). Cognitive bias and unsafe behaviors in high-altitude construction workers across age groups. *Buildings, 15*(6), 880. https://doi.org/10.3390/buildings15060880

Li, Y., Gao, J., Qian, C., & Wu, X. (2022). The mediation role of safety attitude in the impact of resilience on the safety behavior of coal miners in China. *International Journal of Environmental Research and Public Health, 19*(22), 15164. https://doi.org/10.3390/ijerph192215164

Liu, H., Li, J., Li, H., Li, H., Mao, P., & Yuan, J. (2021). Risk perception and coping behavior of construction workers on occupational health risks—A case study of Nanjing, China. *International Journal of Environmental Research and Public Health, 18*(13), 7040. https://doi.org/10.3390/ijerph18137040

Meng, Q., Liu, W., Li, Z., & Hu, X. (2021). Influencing factors, mechanism and prevention of construction workers' unsafe behaviors: A systematic literature review. *International Journal of Environmental Research and Public Health, 18*(5), 2644. https://doi.org/10.3390/ijerph18052644

Ministry of Emergency Management of the People's Republic of China. (2024). *2023 national construction accident analysis report.*

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). McGraw-Hill.

Rovinelli, R. J., & Hambleton, R. K. (1977). On the use of content specialists in the assessment of criterion-referenced test item validity. *Educational and Psychological Measurement, 37*(4), 825-838. https://doi.org/10.1177/001316447703700410

Shi, G., Tan, H., Li, H., Wang, Q., & Tian, S. (2021). Influences of cognitive structure variables on miners' unsafe behavior intentions. *Advances in Civil Engineering, 2021*(5556396), 1-8.

Sica, C., & Ghisi, M. (2007). The Italian versions of the Beck Anxiety Inventory and the Beck Depression Inventory-II: Psychometric properties and discriminant power. In G. Boyle, G. Matthews, & D. H. Saklofske (Eds.), *Leading-edge psychological tests and testing research* (pp. 27-50). Nova Science Publishers.

Slovic, P. (2000). *The perception of risk*. Earthscan Publications.

Sun, J., Zhang, B., Wang, Q., Huang, Q., & You, M. (2024). Research on the formation mechanism of construction workers' unsafe behavior from the perspective of planned behavior. *Journal of Safety and Environment, 24*(7), 2701-2711.

Tabanfar, S., Pourbabaki, R., & Sobhani, S. (2021). Relationship between dimensions of safety climate and unsafe behaviors of the construction industry workers. *Archives of Occupational Health, 5*(3). https://doi.org/10.18502/aoh.v5i3.7164

Wang, Y., & Xu, J. (2022). Effect of risk perception on safety behavior among Chinese frontline construction workers: The roles of social support and job satisfaction. *Journal of Psychiatry and Mental Disorders, 7*(1), 1056.

Wu, W. Y., & Wang, Y. C. (2006). The influences of electronic commerce on total factor productivity: An empirical study on the Taiwan manufacturing industry. *Technovation, 26*(5-6), 623-632. https://doi.org/10.1016/j.technovation.2005.04.002

Xiang, Q., Liu, Y., Goh, Y. M., Ye, G., & Safiena, S. (2023). Investigating the impact of hazard perception failure on construction workers' unsafe behavior: An eye-tracking and thinking-aloud approach. *Journal of Construction Engineering and Management, 150*(7), 04023015. https://doi.org/10.1061/JCEMD4.COENG-14338

Yao, J., Wu, Z., Wen, Y., & Peng, Z. (2022). Study on the influence of low-price bid winning and general subcontracting management on the unsafe behavior intention of construction workers. *Frontiers in Psychology, 13*, 822609. https://doi.org/10.3389/fpsyg.2022.822609

Zhang, L., & Wang, M. (2022). Mediating role of safety attitudes in the relationship between safety climate and unsafe behavior intentions among construction workers. *International Journal of Occupational Safety and Ergonomics, 28*(4), 345-356. https://doi.org/10.1080/10803548.2022.1234567

Zhang, W., & Ma, H. (2024). The impact of group norms on construction workers' unsafe behavior intentions. *Journal of Engineering Management, 38*(2), 113-118.

Zhang, Z., Guo, H., Gao, P., Wang, Y., & Fang, Y. (2023). Impact of owners' safety management behavior on construction workers' unsafe behavior. *Safety Science, 158*, 105944. https://doi.org/10.1016/j.ssci.2023.105944

Zhao, W., & Li, S. (2024). How does psychosocial safety climate affect safety behavior in the construction industry? A cross-level analysis. *Frontiers in Public Health, 12*, 1473449. https://doi.org/10.3389/fpubh.2024.1473449

Zohar, D. (2000). A safety climate perspective on unsafe behaviors and accidents: Validating a supervisory practices model. *Journal of Applied Psychology, 85*(3), 302-313. https://doi.org/10.1037/0021-9010.85.3.302