The Influence of Chinese Construction Workers' Safety Stress and Risk Perception on Safety Behaviors Based on Structural Equation Model

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Abstract—This cross-sectional study conducted among 356 Chinese front-line construction workers. It aims to explore how the safety stress and risk perception impact safety behavior and to examine the role of risk perception between safety stress and safety behaviors. Structural equation modeling demonstrated that safety stress negatively influenced both safety compliance and safety participation, while the safety stress positively affected risk perception. In addition, risk perception positively impacted on safety compliance, while negatively influenced the safety participation. We also found risk perception had the suppressing effect between safety stress and safety compliance, and the mediating effect between safety stress and safety participation.

Keywords-safety stress; risk perception; safety compliance; safety participation

1 Introduction

Although non-standard technology and equipment are regarded as the key causes of safety accidents, the operation of equipment largely depends on human behavior [1]. It is fair to say that numerous causes contribute to unsafe behaviors, of which is safety stress.

The nature of safety stress is different from that of general work stress. It is the embodiment of the safety results of the workplace. In the construction workplace, there are many factors that lead to stress, such as urgent work tasks, dangerous workplaces, inadequate staff capacity, etc. Safety stress affects the physical and mental health of workers and impairs the safety performance of workers, specifically manifested in interpersonal conflicts caused by safety-related issues, ambiguity and even conflict of safety roles [2]. Sample (2014) and Wang (2018) recorded the negative impact of these safety stressors on safety behavior [2, 3]. However, there was no research to explore the impact mechanism of overall safety stress on safety behavior. According to Griffin and Neal (2006), safety behavior is divided into two dimensions: safety compliance and safety participation. Accordingly, we hypothesized:

H1: safety stress negatively influences safety compliance (H1a) and safety participation (H1b).

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Workers are directly exposed to the risks of the working environment at the construction site. If they realize that they are in a high-risk work environment, they may operate safely to avoid threats to personal safety [5]. Although the research of Kouabenan (2015) shows that there is a positive correlation between risk perception and safety behavior [5]. However, the current research results on the relationship between internal risk identification and external safety performance of workers are still inconsistent. For example, Christian (2015) believes that the level of risk perception in the workplace is a work hindrance demand, which is a personal resource that hinders the performance of personal safety behavior [6]. Xia (2020) found that there is a reverse relationship between workers' risk perception and their safety performance through the study of Chinese construction workers. Thus, further research is needed to clarify the impact mechanism of risk perception on safety behavior. Therefore, we proposed the hypothesis:

H2: Risk perception negatively influences safety compliance (H2a) and safety participation (H2b).

Employees' assessment of safety status and emergency measures is affected by actual working conditions [8]. Rundmo (1996) pointed the physical working conditions correlated with individuals' risk perception [8]. Lopez and Marvan (2003) found the high level of work stress led to high more risk perception [9]. Traczyk (2015) also documented the positive relationship between stress and risk perception [10]. We, therefore, proposed the hypothesis:

H3: safety stress positively influences risk perception

Therefore, it makes us wants to further explore whether risk perception has an intermediary role between safety stress and safety behavior. In accordance with Tolman's cognitive behavior theory, the safety stressors in the objective environment will affect the individual's risk perception, which in turn affects the individual's safety behavior [11]. According to social cognitive theory, the relationship among environment, individual and behavior is mutual, that is, external stimuli act on the body and then show it in behavior [12]. Based on the above theories, we can guess that safety stress will promote risk perception, then affecting safety behavior. Based on this rationale, we hypothesized:

H4: risk perception has a mediating effect between safety stress and safety compliance (H4a) and safety participation (H4b).

Building on previous studies and theories, the conceptual model of this study is shown in Figure 1. First, we explored the impacts of safety stress on safety compliance (H1a) and safety participation (H1b). Second, we explored the impacts of the risk perception on safety compliance (H2a) and safety participation (H2b). Then, we also explored how the safety stress affected risk perception (H3). Finally, we explored the mediating effect of risk perception on the relationships of safety stress with safety compliance (H4a) and safety participation (H4b).

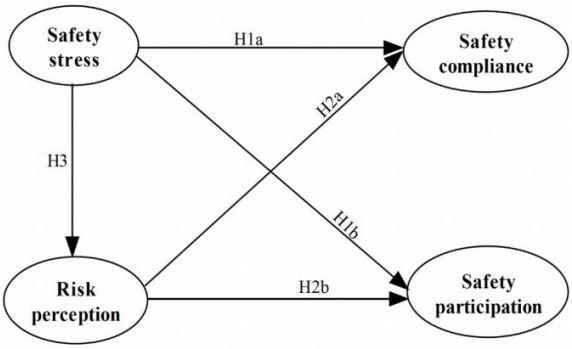

Figure 1. Conceptual model and hypotheses of the study

2 Materials and Methods

2.1 Procedures and participants

From December 24, 2020, to February 2, 2021, 500 questionnaires were distributed at 12 construction projects in Chengdu, China. A total of 391 questionnaires were collected. Questionnaires that were incomplete, unclear, and not seriously answered were omitted. A total of 356 valid questionnaires were collected from front-line construction workers, with an effective recovery rate of 71.20%.

2.2 Measures

Three scales were used in this study. The safety stress was measured using 13-item the scale of Sampson et al. (2014) [2]. Risk perception was assessed using 9 items the scale of Hayes (1998) [13]. Safety compliance and safety participation were measured by 3 items, respectively [4]. All items were scored using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). All the scales have been proved to have good reliability and validity [2, 4, 7]. In this study, Cronbach's alpha was used to test the internal consistency, among which Cronbach's alpha of safety stress was 0.898, risk perception was 0.939, safety compliance was 0.862, and safety participation was 0.876.

2.3 Statistical analysis

SPSS 26.0 was used for descriptive statistics and internal consistency. Then, we used Mplus 8.3 software, conducting the structural equation model (Fig. 1), with maximum likelihood estimation (ML). Delta method with 1000 non-parametric was used to calculate mediation effect.

3 Results & Discussion

This part consists of three subparts, structural equation model testing, mediation effect test and results discussion.

3.1 Model testing

The conceptual model (Fig. 1) showed reasonable fit based on most of the indices: ML $\chi 2$ (129, N = 356) = 375.304, $p < 0.001$, CFI = 0.938, TLI = 0.926, RMSEA = 0.073 (90% CI 0.069- 0.076), and SRMR= 0.046. As shown in Fig.2, relationship among the variables were further analyzed using a structural model with standardized parameter estimates. We found that safety stress had a significant negative association with both safety compliance (β = - 0.336, $p < 0.001$) and safety participation (β = - 0.321, $p < 0.001$), leading to the supporting of H1a and H1b. In contrast, risk perception had a significant positive influence on safety compliance (β = 0.164, p = 0.026), while negatively influencing safety participation (β = - 0.195, p = 0.006), leading to the rejection of H2a, and supporting of H2b. In addition, we also found that safety stress positively influenced risk perception (β = 0.226, p = 0.002), supporting H3.

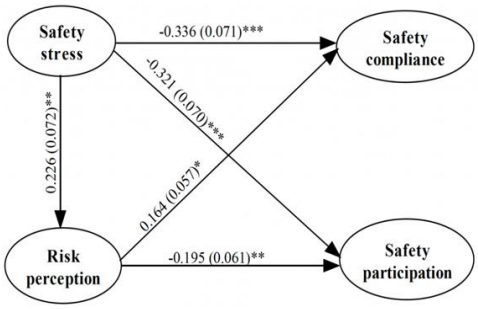

Figure 2. Structural model of safety stress predicting safety compliance and safety participation through risk perception, with standardized path coefficients and SEs (in parentheses). *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$.

3.2 Mediation analysis

As shown in Table 1, these indirect effects were assessed by estimating the cross-product of two direct paths. The mediation analysis indicated that risk perception had a suppressing effect between safety stress and safety compliance (β = 0.037, p = 0.021), rejecting H4a. However, risk perception did appear to mediate the relationships of safety stress with safety participation (β = - 0.044, p = 0.013), supporting H4b.

Table 1. Analysis of the role of risk perception between safety stress and safety behaviors

Indirect effect	β	SE	z	p
SS-> RP ->SC	0.037	0.014	2.398	0.021
SS-> RP->SC	-0.044	0.020	-2.632	0.013

Note: SS (safety stress), RP (risk perception), SC (safety compliance), SP (safety participation)

3.3 Discussion

This study examined the impact mechanism of safety stress over safety compliance and safety participation, and intermediary effects of risk perception between the two. The research results show that safety stress has a direct hindrance to safety behavior, that is, it has passive impacts over both safety compliance and safety participation. Risk perception has positive impacts

over safety compliance and passive impacts over safety participation; Safety stress has positive effects over risk perception. In addition, risk perception acts as a suppressor between safety stress and safety compliance, and plays an intermediary role between safety pressure and safety participation.

Although several studies had documented safety stressor had negative influences over workers' safety behavior, this is the first time to study the influences of safety stress over safety behavior from a comprehensive perspective. Our results had shown that safety stress negatively influenced both safety compliance and safety participation, which was in line with previous studies [2, 3]. Therefore, managers could improve workers' safety behavior by reducing construction workers' safety stress. For example, to actively coordinate interpersonal conflicts and reduce workers' role ambiguity and role conflict.

This study had documented risk perception could positively influence safety compliance, while negatively influencing safety participation. This conclusion confirmed the controversy in previous studies, to wit, some scholars proposed that risk perception had passive impacts over safety behavior [6, 7], while others believed that risk perception had a positive role in promoting safety behavior [5]. This study proved that risk perception had a positive role in promoting safety compliance behavior, while hindering safety participation behavior in a negative way. It showed that on the one hand, allowing construction workers to have a certain risk perception of construction can improve workers' compliance with safety stipulations and regulations. On the other hand, a higher level of risk perception would reduce construction workers' safety participation.

This study was the first to study the linkage between construction workers' external safety stress and internal risk perception. This study had found safety stress could influence the construction workers' risk perception, which were consistent with the previous theories [11,12]. We also found risk perception could suppress the passive impacts of safety stress on safety compliance. To some extent, when construction workers had a high level of risk perception concerning the construction site, even in the environment with high safety stress, whose unsafe behavior would decrease by a large margin. However, the risk perception could mediate the relations between safety stress and safety participation. That is to say, safety stress could decrease the workers' safety participation through improving the workers' risk perception.

4 Conclusions

This study constructed a structural equation model to study the predictive capability of safety stress and risk perception over safety behavior. We not only discovered the passive impact of safety stress over safety compliance and safety participation, but also the positive impact of safety stress over risk perception, and the positive impact of risk perception over safety compliance and safety participation are negatively correlated. In addition, we also found the risk perception inhibition effect between safety stress and safety compliance, and the intermediary effect between safety stress and safety participation. It is reasonable to infer that to improve construction workers' risk perception can hinder negative impacts of safety stress over safety compliance, while promoting passive impacts of safety stress over participation in safety behavior.

References

[1] Zhou, Z., Goh, Y.M., Li, Q. (2015). Overview and analysis of safety management studies in the construction industry[J]. Safety science, 72: 337-350.

[2] Sampson, J.M., DeArmond, S., Chen, P.Y. (2014). Role of safety stressors and social support on safety performance. Safety Science, 64, 137-145.

[3] Wang, D., Wang, X., Xia, N. (2018). How safety-related stress affects workers' safety behavior: The moderating role of psychological capital. Safety science, 103, 247-259.

[4] 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[J]. Journal of applied psychology, 91(4): 946.

[5] Kouabenan, D.R., Ngueutsa, R., Mbaye, S. (2015). Safety climate, perceived risk, and involvement in safety management. Safety Science,77, 72-79.

[6] 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.

[7] Xia, N., Xie, Q., Hu, X., Wang, X., Meng, H. (2020). A dual perspective on risk perception and its effect on safety behavior: A moderated mediation model of safety motivation, and supervisor's and coworkers' safety climate. Accident Analysis & Prevention, 134, 105350.

[8] Rundmo, T. (1996). Associations between risk perception and safety[J]. Safety Science, 24(3): 197-209.

[9] Lopez-Vazquez, E., Marvan, M.L. (2003). Risk perception, stress and coping strategies in two catastrophe risk situations[J]. Social Behavior and Personality: an international journal, 31(1): 61-70.

[10] Traczyk, J., Sobkow, A., Zaleskiewicz, T. (2015). Affect-laden imagery and risk taking: the mediating role of stress and risk perception[J]. PloS one, 10(3): e0122226.

[11] Homans, G.C. (1958). Social behavior as exchange[J]. American journal of sociology, 1958, 63(6): 597-606.

[12] Bandura, A. (2001). Social cognitive theory: An agentic perspective[J]. Annual review of psychology, 2001, 52(1): 1-26.

[13] Hayes, B.E., Perander, J., Smecko, T., Trask, J. (1998). Measuring perceptions of workplace safety: Development and validation of the work safety scale. Journal of Safety Research., 29(3), 145-161.