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Exploration of relationships between safety performance and unsafe behavior in coal mining processes

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Abstract

It is well known that safety performance is differentiated to two components, namely, safety compliance and safety participation. However, relationships between safety performance and unsafe behavior were barely explored. In this work, the scales for safety compliance and safety participation were slightly revised for usage in coal mining processes, and job burnout scale was developed on the basis of MBI-GS. Then, structural equation model was employed to investigate the interaction of these factors using samples of 367 front-line coal miners in large state-owned mining companies in China. The results show that individual unsafe behavior could not be diminished significantly by only focusing on these two dimensions of safety performance. Compared with safety participation, safety compliance has more significant influence on unsafe behavior, and job burnout is an indispensable moderator between these two components and unsafe behavior. More importantly, it is vital to pay close attention to employees' occupational psychological health problem for improving organizational safety management and promoting personal performance.

Keywords: Safety compliance, safety participation, unsafe behavior, job burnout

1 Introduction

Safety compliance and safety participation are two widely approved dimensions of safety performance, which introduced by Neal et al. [1,2] on the basis of work performance theory [3]. These two dimensions are different with each other remarkably, for safety compliance refers to the core activities related to safety which need individuals to perform on the purpose of maintaining the safety in their workplace, such as wearing safety equipment. And safety participation refers to

individuals voluntarily participating in activities related to safety, that is beneficial to the development of a safety-supportive environment and do not contribute to their personal safety directly, such as helping coworkers [2,4]. The relationship between safety compliance, safety participation and accidents, injuries are explored in various industries. Beyond all question, workers' high level of safety compliance and safety participation will predict a low rate of accident and less injuries. However, the relationship between these two dimensions and employees' unsafe behavior, to the authors' knowledge, has not been investigated. It is unwise to make a hasty conclusion that if one conduct safety compliance and safety participation, then he will not commit unsafe behavior. Thus, the mechanisms by which these two dimensions affect unsafe behavior disturb us a lot. Another question bothered us is which dimension, that is, safety compliance or safety participation, contribute more to the diminishing of workers' unsafe behavior.

Furthermore, by inference, we could infer that safety compliance or safety participation will contribute the reduction of unsafe behavior. The reason may be listed as, on the one hand, as abovementioned, these two dimensions will forecast less accidents and injuries. On the other hand, unsafe behavior is the immediate and primary cause of these safety outcomes. However, on the ground of job demands-resources (JD-R) theory [5,6], safety compliance and safety participation belong to motivation factors, and unsafe behavior pertains to organizational outcomes [7]. The interplay between these two dimensions and unsafe behavior may be impacted by strain factors. Strain factor refers to causes that could undermine employees' energetic resources to reach their work goals, which mostly pay attention to psychological health factors in workplace, for example, job-related anxiety and job burnout [6]. And job burnout is the most representative factors, which belongs to employees' psychological syndrome related to work and has been widely discussed in various groups, such as teachers, nurses. Also, mainly front-line manual workers, for example construction worker and coal worker, suffer from this syndrome [8]. Nahrgang et al. [9] and Tong et al. [7] have reported job burnout could influence workers' unsafe behavior. However, what's the role that job burnout plays on the relationship between safety compliance, safety participation and unsafe behavior, which is barely explored and is another problem interested us a lot. To sum up, what we want to reveal is the interrelationship among safety compliance, safety participation, unsafe behavior and job burnout associated with front-line workers, which on the basis of the industry we have been focused on, that is, construction industry, a pure high-risk and labor-intensive industries.

As one of the high-risk industries worldwide, construction has the characteristics of unique, complex and dynamic [10,11]. Its complex and hazardous project site conditions, dynamic resources involved staff, equipment and materials, combined with the millions employment opportunities it provided differentiate construction from other industries [12,13]. Thus, construction has obtained a lot of attention, also the safety management related to it and the health and well-being of its workers [14]. To improve the safety management, many researches related to various aspects have been conducted, among which included the works associated with employee' safety compliance, safety participation and unsafe behavior, especially for the front-line workers. And lots of efforts have been devoted to investigate variables which influence the abovementioned factors [15], also, the relationships between these factors and accidents and injuries have been explored. However, the relationship between safety compliance, safety participation and unsafe behavior, resemble other industries, has been ignored. What more, the job

burnout gets more and more attention in this industry recently, some valuable works have been done [16-19]. But these mainly focused on project managers or site engineers, the special empirical study for construction workers related to their job burnout was lacked, let alone the role burnout plays on the relationship between these two dimensions of safety performance and unsafe behavior.

Therefore, with this background, focusing on construction workers in the Chinese context, at first, the interaction among the aforementioned factors are identified and the hypotheses are presented on the ground of literature reviewing. Then safety compliance and safety participation scales are slightly adapted, and job burnout scale are developed for use in the worker's sample. Third, a survey is performed that sampled construction workers and based on which a quantitatively analysis is conducted to examine our hypotheses. Further, an in-depth discussion is performed and some recommendations are provided to effectively manage employees' unsafe behavior and improve their safety, health and well-being.

2 Literature Review and Hypotheses

2.1 Safety compliance, safety participation and unsafe behavior

Safety performance was traditionally measured by accident rates, fatality rates or TRIFR (total recordable injury frequency rate) [20]. However, these measures are all lag indicators and have been blamed because they are reactive naturally, "insufficiently sensitive, of dubious accuracy, retrospective, and ignore risk exposure" and cannot provide early warnings of injuries or accidents [21,22]. Thus, leading indicators are introduced to better measure safety performance [23]. Among which, safety compliance and safety participation are useful indicators and have been widely approved [1,2,24].

Having a review to the works related to these two dimensions, we can find that, safety compliance and safety participation are generally treated as mediators and outcome variables. Either they are proposed as mediators or outcome variables, the predictors mainly focus on safety climate and safety leadership, both of which will contribute to workers' favorable performance [25-27]. And it is worth mentioning that the researches related to safety leadership primarily pay attention to transformational and transactional styles. When they are treated as mediators, the safety outcomes mainly focus on accidents and injuries, and as mentioned, safety compliance and safety participation are the useful antecedents of the reduction of these two undesirable results.

Apropos of unsafe behavior, the fact that it is the immediate and primary cause of accidents and injuries is beyond any doubt. Combined with the reviewing back of safety compliance and safety participation as abovementioned, we could forcefully deduce that both of these two dimensions would have a negative effect on unsafe behavior. Thus, hypothesis 1 and 2 could be formulated and presented as followed.

Hypothesis 1: Safety compliance of construction workers is negatively related to their unsafe behavior.

Hypothesis 2: Safety participation of construction workers is negatively related to their unsafe behavior.

Then, considering the characters of construction workers, they consist basically of migrant workers who come from countryside, poorly educated, unskilled and inexperienced. And the general pattern of their families is the male labor force comes out alone and is hired as construction worker to win the bread of his family, leaving other family members home. Thus, the burden of

raising the whole family is extremely heavy which make them deem very highly of the financial payback, and the more schedules they finish the more wages they will get. Therefore, it is not uncommon for these workers to scarify the voluntary safety activities (i.e. safety participation) to a larger degree than the core safety activities (i.e. safety compliance) for the duration of finishing the work schedules, combined with safety compliance is generally required and always directly related to intangible (e.g. verbal praise or abuse) or tangible (e.g. bonus or fine) reward or punishment, especially the latter, hence hypothesis 3 could be formulated and listed as followed.

Hypothesis 3: Compared with safety participation, construction workers' safety compliance is more significantly related to their unsafe behavior.

2.2 The role of job burnout

To describe the psychological syndrome that employees prolonged response to chronic emotional and interpersonal stressors on their job, job burnout was coined, and it is predominantly defined by three main components, that is, exhaustion, cynicism and low professional efficacy [28,29]. The first component refers to employee's feelings of being overextended and depleted of his or her emotional and physical resources, and this component pictures the basic individual stress dimension of job burnout. And the second component refers to employee responses to his or her job in a negative, hostile, or an excessively detached attitude, also a loss of idealism is often included, and this component pictures the interpersonal dimension of job burnout. Then, the third component refers to employee declining feelings of competence and productivity at his or her work, and this component pictures the self-evaluation dimension of job burnout.

It is reported that construction workers [30] suffered from job burnout and burnout would contribute to their unsafe behavior [9]. Nahrgang et al affirmed that the correlation relationship between compliance (which was defined equal to safety compliance), engagement (equal to safety participation) and burnout was negative [9], but the specific relations among these factors and unsafe behavior were not mentioned. However, what we attempt to discover, which is also unclear and barely delved, is the specific role job burnout plays on the relationship between safety compliance, safety participation and unsafe behavior. There are two roles job burnout may act, that is, mediator and moderator. A mediator refers to a variable which explains the relationship between a predictor and an outcome, and a moderator refers to a variable which alters the strength or direction of the relationship between a predictor and an outcome [31,32]. It is inescapably clear that job burnout cannot be a mediating role either between safety compliance or safety participation and unsafe behavior. Thus, job burnout could be conjectured act as a moderator between these two dimensions and unsafe behavior. To be detailed, the negative effects between safety compliance or safety participation and unsafe behavior would be intervened by job burnout, and the moderator effect may depend on the significant of job burnout. Due to these, hypothesis 4 and 5 could be formulated and presented as followed. What's more, in contrast to the justifications we proposed hypothesis 3, we formulated hypothesis 6, which is also presented as followed.

Hypothesis 4: As for construction workers, all the three components of job burnout, namely, exhaustion (4a), cynicism (4b) and low professional efficacy (4c) significantly moderate the relationship between safety compliance and unsafe behavior.

Hypothesis 5: As for construction workers, all the three components of job burnout, namely, exhaustion (5a), cynicism (5b) and low professional efficacy (5c) significantly moderate the relationship between safety participation and unsafe behavior.

Hypothesis 6: Compared with the relationship between safety compliance and unsafe behavior, the relationship between safety participation and unsafe behavior is more significantly influenced by all the three components of job burnout, namely, exhaustion (6a), cynicism (6b) and low professional efficacy (6c).

The theoretical model which could illustrate these relations are showed as Figure 1. It presents the influence of two antecedents, namely safety compliance and safety participation on unsafe behavior. Also, it shows the moderator between these two antecedents and unsafe behavior, that is job burnout.

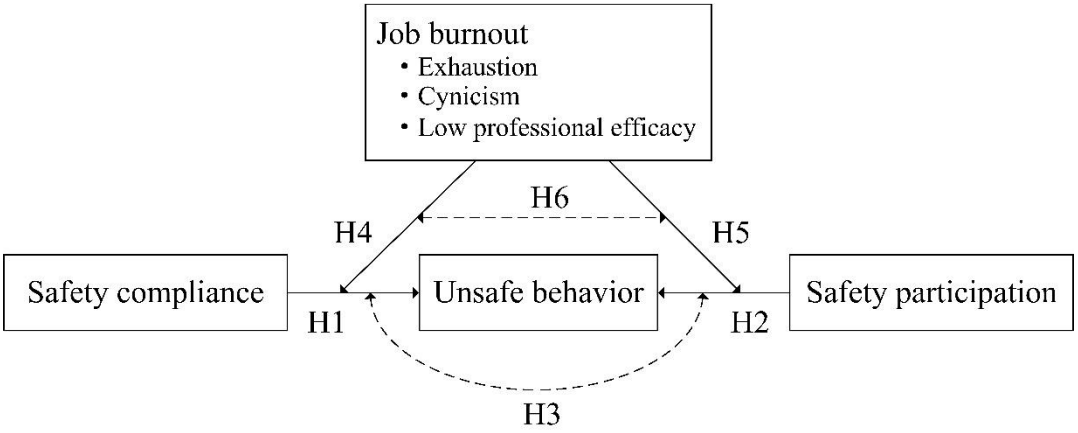


Figure 1- The theoretical model in this study

3 Methodology

3.1 Measures and instruments

The scales and questionnaires include safety compliance and safety participation scales, job burnout scales, and unsafe behavior scales, based on which the questionnaires were developed. A 5-point Likert scale was adopted, which scored from 1 (completely disagree) to 5 (completely agree).

3.1.1 Safety compliance and safety participation

To assess safety compliance and safety participation, several peers had developed scales, such as Neal et al. [1,2], DeArmond et al. [33] and Guo et al [23], among which the scale developed by Neal et al. is the most widely employed. Generally, this scale was revised for use in the participants which were sampled. Considering the participants which we sampled, to suit construction workers' characteristics and real scene, also the Chinese culture, the scale adopted in our work was also revised.

Firstly, the draft scale, which involved the contents and substance of safety compliance and safety participation, was obtained based on Neal et al. [1,2]. And secondly, this initial scale was discussed with 10 squad leaders and 5 full-time safety inspectors who came from two ongoing construction projects which belonged to Crland company and sited in Beijing, China. Crland is a large state-owned real estate enterprise, which employs at least 30, 000 staff and has more than

229 projects sited in 60 cities in China by the end of 2017. The former, who also is one of the members of his team and may come from the same rural area with the other co-workers, is generally responsibility for the work safety and acts as a front-line safety supervisor, and is in charge of the work schedule as well. While, the latter is employed to supervise construction workers, including the squad leaders, and their only duty is to ensure work safety. The common ground is both of them are familiar with the safety and the group of workers. And two-thirds them are construction worker. All of these was to insure the effective of these discussions, and some value information were got, hence to ensure the revised scale was readable, having good face validity and friendly.

Then, according the advices we obtained, all the items of safety compliance and safety participation were weighed and some revises were conducted, for instance, some words were replaced and some examples were given to make the expression clearer. After finishing this, on the purpose of examining the available and quality of the scale, a sample of 100 construction workers from the same two projects which we invited squad leaders and safety inspectors, each project provided half the samples, were invited to perform a pilot survey. Finally, a total of 87 responses and 79 valid responses, which respectively account for 87.0% and 90.8%, were received. Once again, the items were slightly altered and the item-to-total correlation of all the items exceeded 0.40 on the basis of examination of reliability and correlations [24], the employed scale was presented in Table 1.

Table 1 The scale of safety compliance and safety participation

Components	**Items**	
Safety compliance	SC-1	I use all the necessary safety equipment to do my job, such as keeping safety helmets even if it feels uncomfortable
	SC-2	I follow the required safety rules and procedures to carry out my job, such as safety operational instructions
	SC-3	I ensure the highest levels of safety when I carry out my job, such as checking the environment to before doing my work
Safety participation	SP-1	I always point out to my squad leader or safety inspector if any safety related matters are noticed
	SP-2	I put in extra effort to improve the safety of my work, such as reforming the way the job is done to make it safer
	SP-3	I voluntarily carryout tasks or activities that help to improve workplace safety, such as attending non-mandatory safety-related meetings

3.1.2 Job burnout

To assess job burnout, there are also several scales, such as MBI (Maslach Burnout Inventory) [34], OLBI (Oldenburg Burnout Inventory) [35], BM (Burnout Measure) [36] and S-MBM (Shirom-Melamed Burnout Measure) [37]. Among which the serious of MBI are the most popular and widespread, and this instrument involves 3 distinct versions and can be further differentiate to 5 specific versions [34]. To be detailed, the MBI-HSS (Human Services Survey) which for healthcare professionals and MBI-ES (Educators Survey) which for teachers were initially developed, then focusing on general occupations, the MBI-GS (General Survey) was developed.

Afterwards, MBI-HSS was further revised and MBI-HSS(MP) for Medical Personnel was introduced, and MBI-GS was revised for students, the MBI-GS(S) was introduced.

Employed MBI-GS, many researches related to job burnout have been performed in different occupations. However, it was recommended that this instrument which surely was a perfect fundamental scale to measure burnout should be further developed on the basis of characters the specific occupation, especially for construction [19]. Yang et al. have developed an occupation-oriented burnout scale for Chinese construction project managers based on MBI-GS [19]. However, focusing on construction workers in China, to our knowledge, there isn't the special scale to assess their job burnout. Thus, on the same ground of we revised the scale of safety compliance and safety participation, the job burnout scale was developed based on MBI-GS.

Firstly, 10 squad leaders and 5 construction workers were invited to respectively discuss their experience and symptoms of job burnout and each interview lasted for about 1 to1.5 hours. After finishing the interview, the three components of burnout and all the items of MBI-GS were showed to them to have another discuss. The education level of the participants was junior high school or high or technical secondary school, and their work experience varied from 10 to 20 years with an average of 12.5. Hence, we could make sure that their education level can represent the level of their group and they can grasp the purpose of the interview and hence provide some valuable suggestions. Also, their work experience in this industry could ensure them in-deep understanding the particular of this industry.

After finishing these interviews, a total of 37 symptoms which were related to their job burnout and 9 suggestions which were advised to revise the items of MBI-GS were earned. To have an in-depth analysis of these results, it was found that construction workers' symptoms were well covered by the three components of job burnout, that is, exhaustion, cynicism and low professional efficacy. Thus, the draft scale of job burnout for construction worker were developed, which contained 19 items. In order to cover all the symptoms related to burnout experienced by the workers, 3 items were extracted from OLBI, BM and MBI-HSS. Due to the gaps of different culture and linguistic expression, all the items were revised to make them more readable and intelligible to construction workers in China.

Then, a pilot survey was conducted to examine the available and quality of the scale, same to safety compliance and safety participation, the sample of 100 construction workers from two projects were invited. And a total of 87 responses and 76 valid responses, which respectively account for 87.0% and 87.4%, were received. Based the survey, the exploratory factor analysis was performed, in other words, the principal component analysis was conducted to get the factor-loading matrix, which employed SPSS 24.0. And the Kaiser-Meyer-Olkin value, which was 0.887, was got to insure the appropriate of the analysis. To obtain the final scale, four principles were followed, which also adopted by Yang et al. [19].

It showed that to assess the three components of job burnout, that is, exhaustion, cynicism and low professional efficacy, 5, 6 and 5 items were needed, respectively. Therefore, a total of 16-item scale which aimed to measure job burnout of Chinese construction worker was obtained. And it accounted for 82% of the total variance. Apropos of the reliability index, the Cronbach's alpha (α) was got, which was 0.863, and we obtain the Rotated Component Matrix, which was showed in Table 2.

Table 2 Rotated component matrix of the job burnout scale for construction worker

Items		Components		
		EX	**CY**	**LPE**
EX-1	I feel tired and fatigued after work	0.889	—	—
EX-2	When I get up in the morning and have to face another day with my job, I feel exhausted before I've even started	0.866	—	—
EX-3	My job makes me feel emotionally drained	0.831	—	—
EX-4	Working all day is really a strain for me	0.829	—	—
EX-5	I am so weak and susceptible to illness	0.757	—	—
CY-1	I always express negative emotions at work	—	0.861	—
CY-2	The meaning of my work is doubtful	—	0.841	—
CY-3	My job bored me a lot	—	0.839	—
CY-4	I feel less and less interested in my job since I was employed	—	0.752	—
CY-5	I have become more cynical about whether my work contributes anything	—	0.703	—
CY-6	I just want to finish my work and not be bothered by other co-workers or things	—	0.702	—
LPE-1	I am able to effectively solve the problems in my work	—	—	0.769
LPE-2	I feel I am making effective contributions to what my company does	—	—	0.698
LPE-3	I am good at my job	—	—	0.689
LPE-4	I feel exhilarated after I dispose of the problem in my work	—	—	0.677
LPE-5	I will feel comfortable when I complete the task effectively	—	—	0.675

Note: EX: Exhaustion, CY: Cynicism, LPE: Low professional efficacy

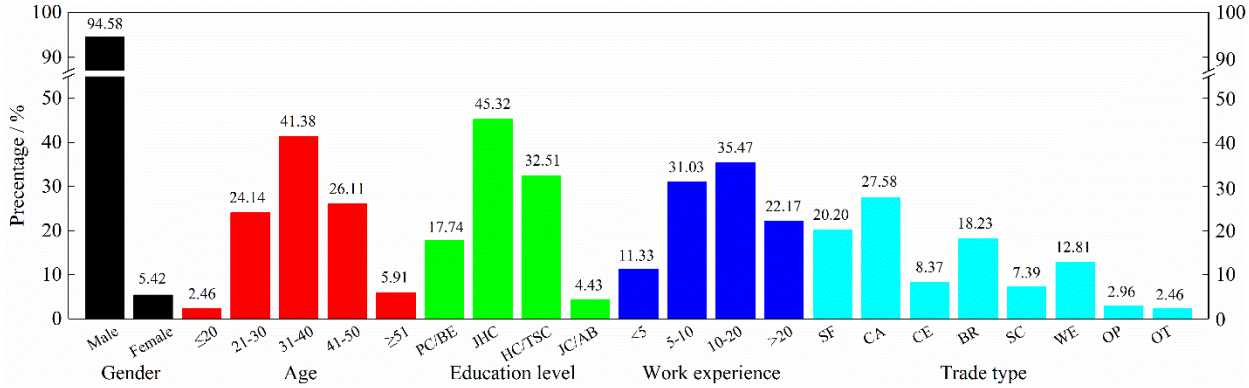
3.1.3 Unsafe behavior

To assess unsafe behavior, according to the method provided by Stride et al. [38], the self-report method was conducted, that is to say, construction workers' experiences of unsafe behavior were asked to recall with a span of the recently four weeks. There are two questions related to their unsafe behavior were asked, showed as "In the past four weeks, how many times unsafe behavior of yourself can you recall when you conduct your job" which related to themselves, and "In the past four weeks, how many times unsafe behavior of your co-workers can you recall when they

conduct their job" which related to others. It is worth mentioning that a period of four-week was selected was suggested by Warner et al. [39] and Landen and Hendricks [40]. To meet the 5-point Likert scale, the results of unsafe behavior were standardized, to be detailed, 1 to 5 point represent the times respectively were 0 to 10, 11 to 20, 21 to 35, 36 to 50 and above 50.

3.2 Participants

The construction workers of the two ongoing construction projects were invited to participate in our empirical study, and finally 287 questionnaires were distributed. After finishing the survey, 236 responses and 203 valid responses, which respectively account for 82.2% and 86.0%, were received. The demographic distribution of the samples was showed in Figure 2. Almost all the respondents were male with the age of 20 to 50, and the education level of them were junior high school or high or technical secondary school. Most of them, which accounted for about 80%, had approximately more than 5 years working experience, and almost all the types of workers were included.



Note: PC/BE: Primary school or below, JHC: Junior high school, HC/TSC: High or technical secondary school,

JC/AB: Junior college or above

SF: Steel Fixer, CA: Carpenter, CE: Cement worker, BR: Bricklayer, SC: Scaffolder, WE: Welder,

OP: Operator of tower crane, OT: Other

Figure 2 - Demographic characteristic of the participants (N=203)

4 Results and Analysis

4.1 Statistical analysis

A confirmatory factor analysis was conducted to test the reliability of the hypothetical model. As illustrated in Table 3, all the values of factor loadings and Cronbach's alpha (α) exceeded 0.6. Thus, it showed that all the factors and dimensions, which involved in the hypothetical model we developed, were considered reliable.

Table 3 Confirmatory factor analysis of the factors in this study

	Safety compliance	**Safety participation**	**Job burnout**		
			Exhaustion	Cynicism	Low professional efficacy

Loading	0.817	0.826	0.821	0.793	0.765
α	0.805	0.809	0.801		

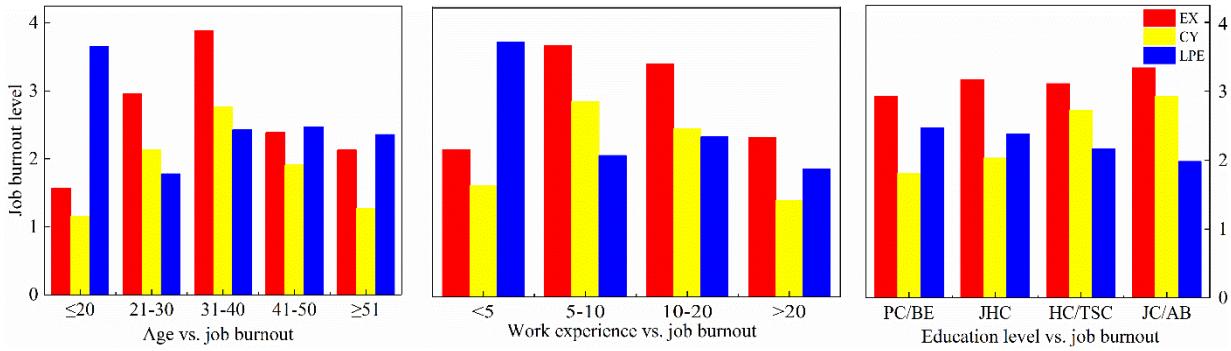
When it comes to the level of safety compliance, safety participation, unsafe behavior and job burnout, they were all presented in Table 4. We could find that construction workers have a high level of safety compliance and a medium level of safety participation with the values of 3.84, 2.49 respectively. The higher value of safety compliance indicated that it is the core safety activities in some degree, which is in consist with the previous works [2,15,41]. And according to the construction workers' self-report, the level of their unsafe behavior was relatively high with an average of 3.12, which means their unsafe behavior times were about 30. But it is noteworthy that this may be biased, to be detailed, it may be lower than their real level, the reasons may be listed as, on the one hand, they may conceal the truth for fear of being punished, on the other hand, they may forget or ignore some types of unsafe behavior.

Based on the recommendations provided by Maslach [42], the average item score of each component related to job burnout was employed to represent the level of construction workers' burnout. Maslach also pointed that a value exceeds 2.70 and 1.80 for exhaustion and cynicism are high, and a value less than 3.30 are low [42]. When it comes to construction worker, these three values were respectively 3.11, 2.26 and 2.31, which showed actually high level of job burnout.

Table 4 The level of the factors in this study

	Safety compliance	**Safety participation**	**Unsafe behavior**	**Job burnout**		
				Exhaustion	Cynicism	Low professional efficacy
Observed	3.84	2.49	3.12	3.11	2.26	2.31
Level	High	Medium	High	High	High	Low

Further, the relationship between construction workers' age and their job burnout level were compared, as showed in Figure 3, also the work experience and education level, which were showed in the same illustration. As we can see, workers between 21 to 50 years, who were the main body of construction workers, had the higher level of burnout, among which workers between 31 to 40 years had the highest level of exhaustion and cynicism, and the workers between 21 to 30 years had the lowest level of low professional efficacy. We could also find that workers who had an experience of 5 to 20 years had the higher level of burnout, and these who had a 5 to 10 years of experience had the highest level of exhaustion and cynicism and the lowest level of low professional efficacy. However, there was no significant difference between education level and job burnout.



Note: EX: Exhaustion, CY: Cynicism, LPE: Low professional efficacy

PC/BE: Primary school or below, JHC: Junior high school, HC/TSC: High or technical secondary school,

JC/AB: Junior college or above

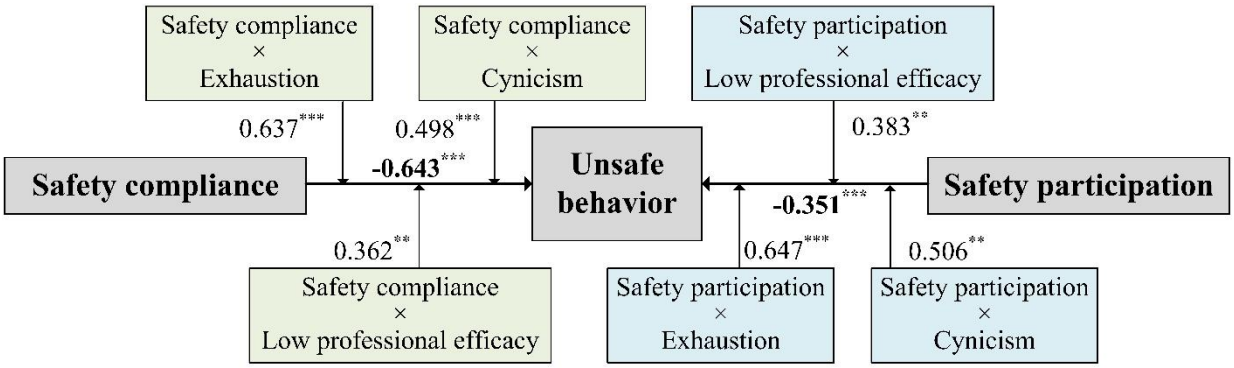
Figure 3- The relationship between age, work experience, education level and job burnout

4.2 Hypotheses testing and analysis

A regression analysis was performed to examine the hypothetical model employed SPSS Amos 24.0, hence the accepted model was obtained and showed as Figure 4. To test the hypotheses, the significant levels were also present in Figure 4. Then, in order to test the fitness of the model, the fit indices were got, as illustrated in Table 5, which showed a relatively high level of fit.

Table 5 Fit indices of the accepted structural equation model

Index	GFI	RMR	RMSEA	AGFI	NFI	CFI	IFI
Value	0.902	0.074	0.087	0.876	0.887	0.893	0.892
Evaluation	Good	Moderate	Moderate	Good	Good	Good	Good



Note: **P<0.01, ***P<0.001

Figure 4 - The accepted hypothetical model in this study

4.2.1 Relationships between safety compliance, safety participation and unsafe behavior

Hypothesis 1 and Hypothesis 2 proposed that construction worker' safety compliance, safety participation should be negatively related to their unsafe behavior, respectively. To the former, the results strongly supported it, because safety compliance was significantly related to unsafe

behavior. Also, the results supported the latter, but the significant was a little low. Then, comparing the negative effect of these two dimensions on unsafe behavior, we could find that safety compliance contributes more to the diminishing of worker' unsafe behavior, thus Hypothesis 3 was supported. To sum up, the results were supportive of Hypothesis 1 to Hypothesis 3.

To some degree, this result echoed the previous works which explored the relationship between safety compliance, safety participation and accidents and injuries, such as Clarke [43] and Hon et al. [41]. In high-risk industries, the construction included, both safety compliance and safety participation are critical to organizational safety management [44]. And these two dimensions are related with each other, the former is workers' in-role, mandatory performance and directly associates with the health safety themselves, and the latter is workers' extra-role, voluntary performance and can supports organizational overall safety [2,15]. Thus, both of them can block employees commit unsafe behavior.

However, the negative significant of safety compliance and safety participation on unsafe behavior is different. The reason may be listed as, on the one hand, firstly, although these two dimensions are related, they are inherently distinct [2]. Based on the work performance theory, similar to task performance, safety compliance is formal required, thus, with specified requirements, which make this activity be understood and undertaken easily by employees. On the contrary, similar to contextual performance, safety compliance is informal required, hence, without clear requirements [2,15]. Then, employees' compliance activities are generally monitored by their supervisors, while their participation activities are mainly discretionary. Thirdly, the former is directly related to workers' health and safety, more importantly it associated with their salaries, while the benefits brought by the latter for workers are always indirect and ambiguous [1].

On the other hand, first, given the context of construction, some factors which may impact workers' activities related to compliance and participation are intrinsic and cannot be abated, such as poor workplace environment, risks and hazards, high work pressure. Second, due to safety measures may entail modest benefits while immediate costs, unsafe behavior occurs [41]. Third, which is more significant, unsafe behavior is naturally strengthened, which may attribute to individual tends to deem very highly of short-term results, in orders words, the fruits of taking a shortcut is immediate and motivating, for instance, conducting the jobs with less time and efforts [41]. Therefore, construction workers perform a higher level of safety compliance, which consistent with the previous studies, for example Xia et al. [15] and Lyu et al. [45]. Further, these can explain why safety participation has lower effect on unsafe behavior, which in a sense conform with Hon et al. [41] and DeArmond et al. [33] as well.

4.2.2 The moderating role of job burnout

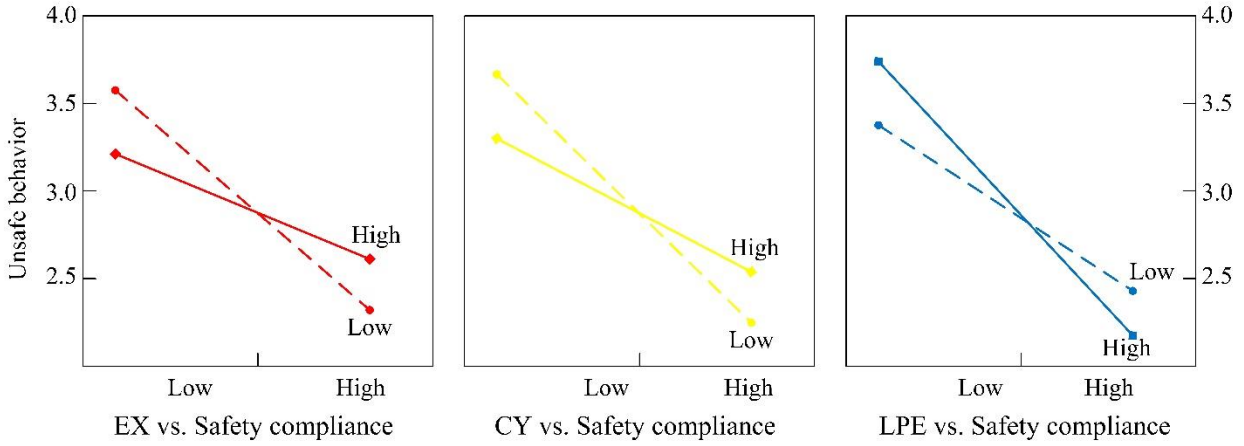
Hypothesis 4 and Hypothesis 5 predicted that the relations between construction workers' safety compliance, safety participation and unsafe behavior were moderated by their job burnout. As showed in Figure 4, all the three components of job burnout had significant influence on the relationships, thus Hypothesis 4 and Hypothesis 5 were supported. However, the difference between these two moderate effects were insignificant, which demonstrated Hypothesis 6 was rejected, that is to say, workers' job burnout had the same influence on altering the strength between the two dimensions of safety performance and unsafe behavior.

To have an in-depth exploration of the moderating role that job burnout plays, the simple slopes which could present the moderating effect of the three components involved in job burnout

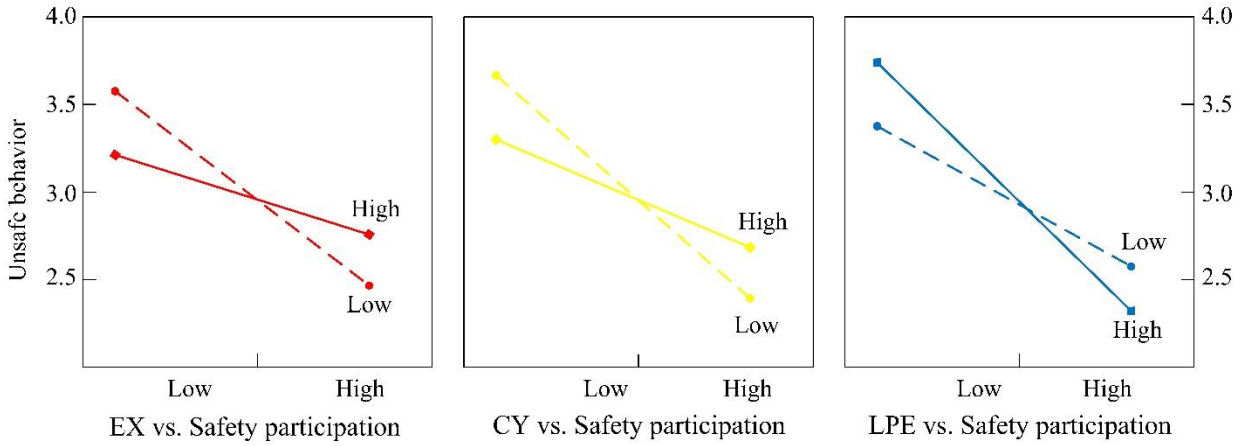
on the relationship between safety compliance and unsafe behavior were depicted in Figure 5 (a). As can be seen, in pace with the ascending of construction workers' safety compliance, their unsafe behavior descended. However, the downtrend was undermined by workers' job burnout, firstly, under conditions of high burnout, to be detailed, high level of exhaustion and cynicism and low level of professional efficacy, construction workers exhibited relatively higher unsafe behavior. Secondly, compared the downtrend, it could be found that the slopes related to exhaustion were the slowest, then that related to cynicism followed, and finally was slopes related to low professional efficacy. Then, it could be found that the slopes related to high job burnout tend to have slower downtrend when compared these two slopes associated with the same components of burnout. Also, the resemblant phenomenon could be found in Figure 5 (b), which presented the moderating role of job burnout on the relation between the other component of job performance on construction workers' unsafe behavior.

Furthermore, compared the slopes in Figure 5 (a) and (b), it could be found that, under conditions of the same job burnout, in the wake of the rising of construction workers' safety compliance and safety participation, the slopes related to their participation present higher level of unsafe behavior, and these slopes showed slower downtrend. As the abovementioned which compared the difference of safety compliance and safety participation and their effect on workers' unsafe behavior, these findings were also the evidence. Moreover, these were supportive of Hypothesis 3 in a sense.

As an "occupational phenomenon", which specifically refers to employees' psychological syndrome in the occupational context [46], job burnout will impact workers' job outcomes, for instance, absenteeism and turnover intention, also workers' safety outcomes. Thus, the relationships between construction workers' safety compliance, safety participation and job burnout were undermined by their burnout. The mechanism may be described as the characteristics of the construction industry, such as the prolonged monotonous jobs and high work intensity, would make the worker undergo exhaustion and energy depletion, then, their mental distance to the job would increase and they may feel negativism or cynicism, and their professional efficacy would be lower and lower with this syndrome worse and worse. Combined with the aforementioned, briefly, both the intrinsic factors of this industries and the naturally reinforced unsafe behavior, these all cause the strength between construction workers' safety compliance, safety participation and their unsafe behavior was abated by their job burnout. What's more, the reasons why the difference of the moderating effect of burnout on the above two relationships was no significantly may be the same causes as well.



(a) The effect on the relationship of safety compliance and unsafe behavior



Note: EX: Exhaustion, CY: Cynicism, LPE: Low professional efficacy

(b) The effect on the relationship of safety participation and unsafe behavior

Figure 5 - Moderating effect of job burnout

4.3 Overview

Based on the analysis of the fore, we could confirm that workers' unsafe behavior cannot decline effectively if the attentions only pay to their safety compliance and safety participation, because they also suffer from job burnout, which is at a really high level and this factor act as a moderating role. To be detailed, the positive relationship between worker' high level of compliance, participation and their low rate of unsafe behavior will be undermined by their poor occupational psychological condition of job burnout. Thus, the question which was proposed in the beginning could be answered.

In retrospect, to achieve the goal which we initially set, the scales for safety compliance and safety participation were slightly adapted for apply in our targeted samples, which both retained their original items. More importantly, the job burnout scale was developed for construction worker in China, which contained 16 items and changed relatively larger, but it was confirmed that the three components of job burnout, namely, exhaustion, cynicism and low professional

efficacy covered their symptoms perfectly. Then, according the survey which sampled construction workers' in Beijing, China, five in six hypotheses we formulated were supported, and the rest one was rejected. And the results were analyzed from the characteristics of the factors, that is, safety compliance, safety participation, unsafe behavior and job burnout, and the samples we invited, also the industry we focused. Furthermore, it is worth noting that the terrible symptom related to construction workers' job burnout reflects their condition of occupational psychological health, which need urgent attention [7], especially in the era of industry 4.0 [47]. Hence, an in-depth discussion was conducted and some management advices concerning workers' behavior intervening were provided in the next section.

5 Discussion

5.1 In-depth analysis

To effectively prevent and control unsafe behavior, on the ground of the results above, not only construction workers' safety compliance and safety participation, but their job burnout should all be concerned. More in-deep considering, the former belongs to traditional factors which could contribute to the mitigation of employees' unsafe behavior, other factors, take safety climate, safety leadership for instance, are also such classes. And the latter, according to occupational health psychology, belongs to occupational psychological factors, other factors, take job security and psychological capital for example, are such classes as well. It is indubitable that traditional factors should be concerned, such as promoting compliance and participation, building positive climate and improving leadership which all related to safety. More importantly, construction workers' occupational psychological factors and occupational psychological health condition should also be taken into account when intervene their unsafe behavior, which is what we want to argue.

The reason may list as, firstly, as we can see in this empirical study, construction workers suffered a high level of job burnout, which severely undermined the mitigation mechanism of their safety compliance and participation on their unsafe behavior. Beyond that, secondly, employees were reported undergo other occupational psychological health problems and some other negative occupational psychological factors were approved had negative influence on their safety outcomes in workplace, give an example, high-speed railway drivers were reported suffered job insecurity which was affirmed negatively related to their compliance and participation [48], psychological distress [49] was another example. And, thirdly, which may be more important, contrary to these adverse problems and factors, employees would also have heath occupational psychological conditions and there are positive psychological factors which could promote safety outcomes. For instance, both psychological capital and psychological contract were all confirmed would contribute to construction workers' safety compliance and participation [4,50]. Consequently, with the development and maturity of occupational health psychology, there is an increased emphasis recently on considering employees' occupational psychological factors when conduct safety management [48,51], also when intervene unsafe behavior [7]. The consensus that employees' occupational psychological health condition and occupational psychological factors should be taken into account when manage safety in workplace has emerged and is strengthening. Hence, for construction workers, it is advisable to consider the issues associated with their occupational

psychology when intervene their behavior. What's more, not only the negative issues, but the positive should both be concerned.

To achieve this, the "dual process management" method and "environment/organization-occupational psychology-behavior" processes which were proposed on the ground of JD-R theory [7], could be followed. For construction workers, to be detailed, to control their unsafe behavior and shape their safety behavior, both the factors related to their occupational psychology which are workers' intrinsic psychological variables, and the factors come from environment and organization which are external workplace variables, should be focused on. According to their effect on workers' behavior, these factors can be categorized as two, one will block construction workers occur unsafe behavior and shape their safety behavior, and the other will lead to their unsafe behavior. And these two factors mainly have two pathways, namely positive and negative, to achieve their influence on workers' unsafe behavior.

Thus, some recommendations for intervening construction workers' behavior were provided as following. First, construction workers' occupational psychological state should be assessed regularly, and some attentions should be paid to the related factors. Such factors involve their job burnout, job insecurity and psychological capital, and so on. And some efforts should be conducted to buffer or enhance these factors. Targeting this, second, as the abovementioned, measures should be taken to improve or strengthen traditional factors which is the predictor of workers' occupational psychological health condition. Such measures include improving the environment of their workplace, strengthening the support of their supervisors and developing smooth channel of communication and feedback for workers' and their managers, and so forth. Apart from that, third, some factors mainly belong to their job characteristics which will also predict construction workers' psychological condition in workplace should be concerned and adjusted, such as work pressure, role overload and complexity of their work. Also, other factors, such as work-family conflict and job autonomy should be considered. What's more, not the factors and the path that contribute to the diminish construction workers' unsafe behavior, but that lead to their unsafe behavior should all be focused.

5.2 Contribution of the study

From the perspective of theoretical literature, three are four aspects this study could contribute to its development. Firstly, the relationships between safety compliance, safety participation and unsafe behavior were detected, and it was verified that worker's unsafe behavior cannot be effectively diminished only focus on their compliance and participation. Secondly, the role job burnout acts as was investigated, it was found that this factor was a moderator on the aforementioned relationships, which indicated workers' burnout should be managed when intervene their behavior. Thirdly, based on the results this study showed, combined with theoretical analysis and literature review, the suggestion that workers' occupational psychological health condition and the related factors should also be considered when conduct researches was proposed. Finally, the scale for construction workers focus on their job burnout in the Chinese context was developed and verified available, which is a reference for peers.

From the perspective of safety management practice in organizations, especially the high-risk industries, take construction for example, there are four aspects this study could contribute to its improvement. At first, another viewpoint for managing workers' unsafe behavior was pointed, that

is, making efforts to maintain the health and stable of their occupational psychological condition, and taking their occupational psychological factors into account when conduct management. Then, the "dual process management" method and "environment/organization-occupational psychology-behavior" processes were recommended to achieve this and conduct safety management for preventing and controlling workers' unsafe behavior. Third, some specific advises were provided for safety managers in construction industries. Fourth, construction worker' safety, health and well-being will improve if their occupational psychological condition was concerned.

5.3 Limitations and future research

Three limitations in this work should be mentioned and the corresponding directions for future research are pointed. First, essentially, the data for examining the hypotheses is cross-sectional. Given that safety management in the sampled construction projects is a process rather a static variable, thus, a longitudinal research should be conducted for further investigating the causal relationship among the variables. Second, only construction workers' job burnout was explored, more research should be performed to explore other factors related to their occupational psychological health and job characteristics, also the interrelations among these factors and workers' unsafe behavior. Third, some empirical study should be executed to verify and renovate the dual process management method for intervening workers' behavior in construction industries, because it was proposed on the basis of meta-analysis [7].

6 Conclusions

This work was motivated to investigate safety compliance, safety participation with unsafe behavior and the role job burnout plays, because so much evidence has indicated the importance of its revealed among high-risk industries workers, such as construction in China. The results showed that workers' compliance and participation certainly contribute to the decrease of their unsafe behavior, but the mitigation mechanism was undermined by their negative occupational psychological condition, that is the symptom of job burnout, which was confirmed a moderator. Then, the present work proposed employees' health of their occupational psychological condition and the related factors should be included when take measures to intervene their unsafe behavior. To achieve this, the "dual process management" method and "environment/organization-occupational psychology-behavior" processes were proposed for referring. In addition, the job burnout scale was developed specially for Chinese construction workers. The findings could contribute to the development of theoretical literature, and were useful for construction managers to improve safety practice, particularly workers' behavior management.

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