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## Social identity, safety climate and safety behavior among mine construction workers

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### Abstract

Creating a sound safety climate is accepted as an effective measure to curb unsafe behavior, which is the primary cause of construction accidents. However, the issue is open to debate as to which factors contribute to a sound safety climate. Using questionnaire responses from mine construction workers, this paper examines the impact of social identity on safety climate and hence safety behavior based on the structural equation modeling technique. Results show that workers who identify themselves primarily with their crews have stronger safety climate perceptions, while those workers who have stronger identification with the construction project have weaker safety climate perceptions. Surprisingly, group safety climate fail to mediate the relationship between workers' group identity and their safety behavior. The results highlight the role of crew leaders in creating a sound safety climate and curbing unsafe behavior.

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*Keywords: Mine construction workers; Safety behavior; Safety climate; Social identity; Structural equation modeling*

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### 1. Introduction

The construction industry is notorious for the frequency of work-related accidents in China. According to the Ministry of Emergency Management, in the first half year of 2018 the construction industry has seen the largest number of work-related accidents, outnumbering the notorious mining industry for nine consecutive years<sup>[1]</sup>. Furthermore, the ministry found that failure to fulfil safety responsibility and prevalent safety violations are the primary causes. Enterprises fail to fulfil safety responsibility reflects that they don't attach importance to safety performance. In other words, they fail to prioritize safety over other competing operational objectives. Safety climate is defined as "shared perceptions with regard to safety policies, procedures, and practices<sup>[2]</sup>", and hence indicates the priority of safety. In a strong safety climate, management commits to safety and employees are involved in safety management. Failure to fulfil safety responsibility is indicative of a weak safety climate. Violations are behaviours<sup>[3]</sup>, and safety violations are unsafe behaviours. Traditionally, regulatory bodies turn to enforcement-based systems in order to improve construction safety performance. Although the enforcement-based approach was effective in reducing accident and fatality rates, the rates are still at an unacceptably high level. Previous research<sup>[4][5][6][7]</sup> suggests that a strong safety climate is

conducive to increasing safe behaviour. Therefore, measures which help the strong safety climate emerge are supposed to help cultivate safety behaviour. However, the literature is unclear about the antecedents of safety climate<sup>[7]</sup>. To fill in this gap, this research introduces social identity as an antecedent of safety climate.

The construct of social identity is relevant to construction practice and related to safety climate perceptions. At large construction sites, many different social subgroups (e.g., concrete work crews) exist along with their own peculiar values and goals. On a daily basis, construction workers interact with co-workers in their subgroups. Further, they are also supposed to follow instructions from the site management. Therefore, they identify themselves in terms of both their crew and the construction site, i.e., they have both group identity and project identity. Different subgroups have different interpretations of the project-wide safety policies and procedures espoused by the site management (i.e., project safety climate) and the safety practices enacted by crew leaders (i.e., group safety climate). Based on questionnaire responses from 478 construction workers at two large Danish public hospital construction sites, Andersen et al. <sup>[8]</sup> found that workers identify themselves predominantly with their work crew, and to a lesser extent with the construction site. Further, they found that social identity and safety climate are related both at the work crew and construction site levels, and the association between social identity and safety climate is stronger at the work crew level. Similarly, in this paper we hypothesize:

H1: Social identity is positively associated with safety climate at both the work crew level and project level.

H2: The association between social identity and safety climate is stronger at the work crew level than at the project level.

H3: The association between group safety climate and safety behaviour is stronger than that between project safety climate and safety behaviour.

The hypothesized structural model is shown in Figure 1.

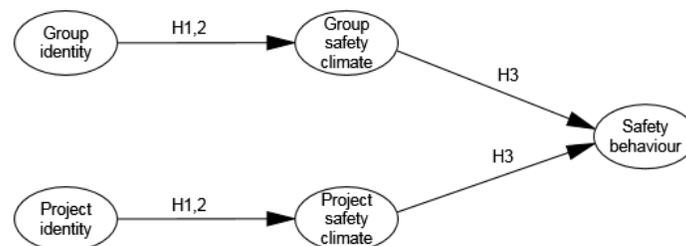


Fig. 1. Hypothesized structural model

## 2. Methods

### 2.1. Participants

After obtaining the clients' approval, an author visited two mines between February and March 2019, administering questionnaires in person. Respondents were assured that completion of the questionnaire was voluntary and responses were used only for research purposes. In total, 300 hard-copies were sent out and 212 valid responses secured, with a response rate of 70.7%. Table 1 shows the demographic characteristics of respondents.

Table 1. Demographic characteristics of respondents

Characteristics	Frequency	Percentage (%)
Gender		
Female	0	0.0%
Male	212	100.0%
Age (years)		

<=20	1	0.5%
20—25	25	11.8%
26—30	63	29.7%
31—35	58	27.4%
36—40	41	19.3%
41—45	22	10.4%
46—50	2	0.9%
<b>Education level</b>		
Below primary	5	2.4%
Primary	36	17.0%
Junior high school	66	31.1%
Senior high school	75	35.4%
Technical secondary school	17	8.0%
Junior college/diploma	9	4.2%
College or higher	4	1.9%
<b>Industrial experience (years)</b>		
<=0.5	5	2.4%
0.5—1	27	12.7%
1—2	54	25.5%
2—5	53	25.0%
5—10	41	19.3%
10—15	21	9.9%
15—20	6	2.8%
>20	5	2.4%
<b>Current job tenure (months)</b>		
< 0.25	7	3.3%
0.25—3	17	8.0%
3—6	62	29.2%
> 6	126	59.4%

## 2.2. Data Analysis

Based on questionnaire responses, the authors tested the hypotheses with the structural equation modelling (SEM) technique. The reasons are twofold. First, it is difficult to measure the constructs involved in the hypotheses directly. In this case, SEM allows multiple measures instead of one single item representing a latent construct, and this provides more adequate representation than using only one single measure. Second, theoretical or abstract concept is unavoidably subject to measurement error which is basically due to inaccurate responses. SEM accounts for the amount of measurement error and present more accurate relationships between constructs.

In general, the SEM technique has two components, i.e., a measurement model assessment component and a structural model assessment component<sup>[9]</sup>. The measurement model represents how a set of indicators (or measures) come together to represent constructs, whereas the structural model shows how constructs are associated with each other. The measurement model assessment component is to measure the reliability and validity of an indicator or a set of indicators in representing the intended constructs. Reliability refers to the degree to which the indicator or the set of indicators is consistent in measuring the intended construct, and validity refers to the degree to which an indicator or the set of indicators is free from systematic errors in measuring the intended construct. After obtaining reliable and valid measures of the constructs, the structural model assessment component is to estimate the relationships between

constructs. Hypotheses are supported when a) the structural model achieves acceptable goodness-of-fit and b) path estimates measuring the hypothesized relationships are statistically significant and in the hypothesized direction.

### 3. Measures

#### 3.1. Group Identity and Project Identity

To measure group identity and project identity, three items were used from Choi et al.<sup>[10]</sup>. They were formulated towards both the work crew level and construction project level, e.g. “I am happy to be a member of my crew” (work crew level), and “I am happy to be a member of the project” (project level). A five-point Likert scale ranging from “Strongly disagree” to “Strongly agree” was used.

#### 3.2. Group Safety Climate and Project Safety Climate

To measure group safety climate, three items were adopted from Zohar and Luria<sup>[11]</sup>. A sample item was “My direct supervisor refuses to ignore safety rules when work falls behind schedule.” To measure project safety climate, three items were also adopted from Zohar and Luria<sup>[11]</sup>. A sample item was “Top management in this project invests a lot of time and money in safety training for workers.” A five-point Likert scale ranging from “Strongly disagree” to “Strongly agree” was used.

#### 3.3. Safety Behavior

To measure safety behavior, three items were adopted from Neal et al.<sup>[12]</sup>. A sample item was “I use the correct safety procedures for carrying out my job.” A five-point Likert scale ranging from “Strongly disagree” to “Strongly agree” was used.

### 4. Results

#### 4.1. Construct Reliability and Validity

In assessing the overall goodness-of-fit of an SEM model, Hair et al.<sup>[7]</sup> suggest four indices, one incremental index (e.g., comparative fit index, CFI), one absolute index (e.g., root mean square error of approximation, RMSEA), the chi-square ( $\chi^2$ ) value and its associated degrees of freedom ( $df$ ). Many indicators are used to assess the reliability and validity of an indicator or a set of indicators in representing the intended constructs. A widely used reliability indicator is the Cronbach’s alpha, with a threshold value of .70<sup>[7]</sup>. Two commonly reported types of validity are convergent and discriminant validity. Convergent validity is the “extent to which indicators of a specific construct converge or share a high proportion of variance in common<sup>[7]</sup>”. Reliability is an indicator of convergent validity. Another indicator of convergent validity is the average variance extracted (AVE), which is calculated as the mean variance extracted for the indicators of the construct. As a rule of thumb, an AVE value of no less than .50 is indicative of adequate convergence. Discriminant validity is the “extent to which a construct is truly distinct from other constructs<sup>[7]</sup>”. The discriminant validity of two constructs is secured if both of their AVE values are greater than the squared correlation estimate between them. Evidence of both convergent and discriminant validity is available after assessing the measurement model. After rounds of modification based on model diagnostics such as standardized residuals and modification indices, a final measurement model with acceptable goodness-of-fit is shown in Figure 2. Table 2 shows means, standard deviations, Cronbach’s alpha, correlations, and AVEs of the latent constructs in the final measurement model.

Table 2. Means, standard deviations, Cronbach's alpha, AVEs, and correlation matrix

Constructs	Cronbach's alpha	Mean	Standard deviation	Constructs				
				GI	PI	GSC	PSC	SB
GI	.856	4.21	.623	.56	—	—	—	—
PI	.899	4.30	.687	.684*	.77	—	—	—
GSC	.875	4.31	.557	.653*	.513*	.71	—	—
PSC	.918	4.51	.639	.358*	.397*	.351*	.79	—
SB	.929	2.92	1.538	.005	.133	.132	.204*	.81

Note: 1) GI = Group identity; PI = Project identity; GSC = Group safety climate; PSC = Project safety climate; SB = Safety behavior. 2) Correlations between constructs are below the diagonal. AVEs are in italics on the diagonal. 3) \*  $p < .05$ .

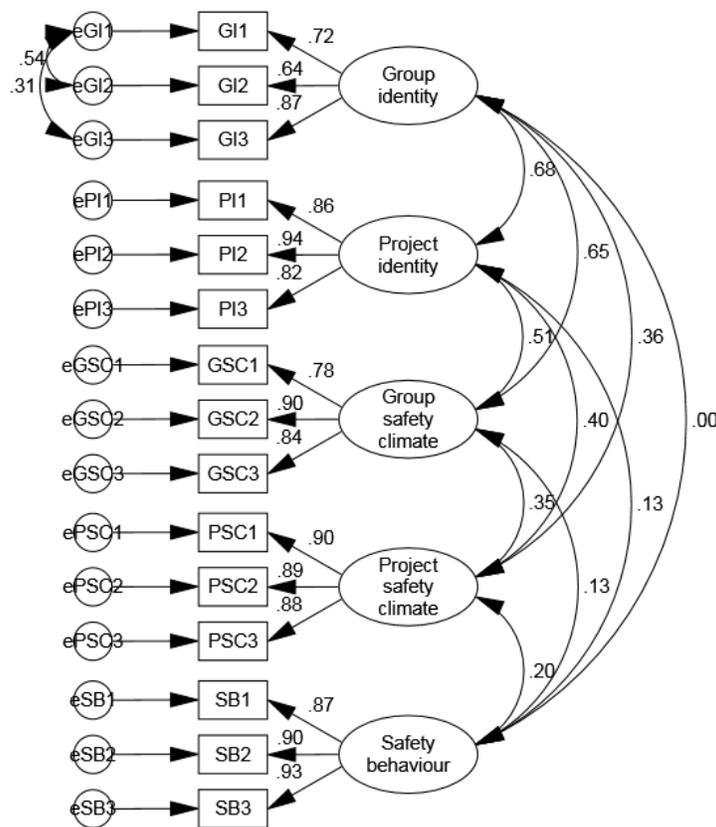


Fig. 2. Final measurement model ( $\chi^2 = 147.41$ ;  $df = 78$ ; CFI = .970; RMSEA = .065)

As shown in Table 2, the Cronbach's alphas were all greater than .70, suggesting construct reliability. All AVEs were no less than .50, suggesting convergent validity. The AVEs of any two constructs were greater than the squared correlations, suggesting discriminant validity. Furthermore, all the factor loadings were statistically significant at the .001 level (two-tailed), and also no less than the threshold value of .60.

#### 4.2. Structural Model and Hypothesis Testing

Figure 3 shows a final structural model with acceptable goodness-of-fit. As shown in the figure, except the standardized path coefficient on the path in red (i.e., .06 on Group safety climate→Safety behavior), all other standardized path coefficients were significant.

Hypothesis 1 states that social identity is positively associated with safety climate at both the work crew level and project level. As shown in Figure 3, the standardized path coefficient on the path of Group identity→Group safety climate was .68 ( $p < .001$ ), and that of the path of Project identity→Project safety climate was .41 ( $p < .001$ ). Hence, Hypothesis 1 was supported.

Hypothesis 2 states that the association between social identity and safety climate is stronger at the work crew level than at the project level. Since the standardized path coefficient regarding the former association (i.e., .68,  $p < .001$ ) was greater than that of the latter association (i.e., .41,  $p < .001$ ), Hypothesis 2 was supported.

Hypothesis 3 states that the association between group safety climate and safety behavior is stronger than that between project safety climate and safety behavior. Because the standardized path coefficient on the path of Group safety climate→Safety behavior was not significant, Hypothesis 3 wasn't supported.

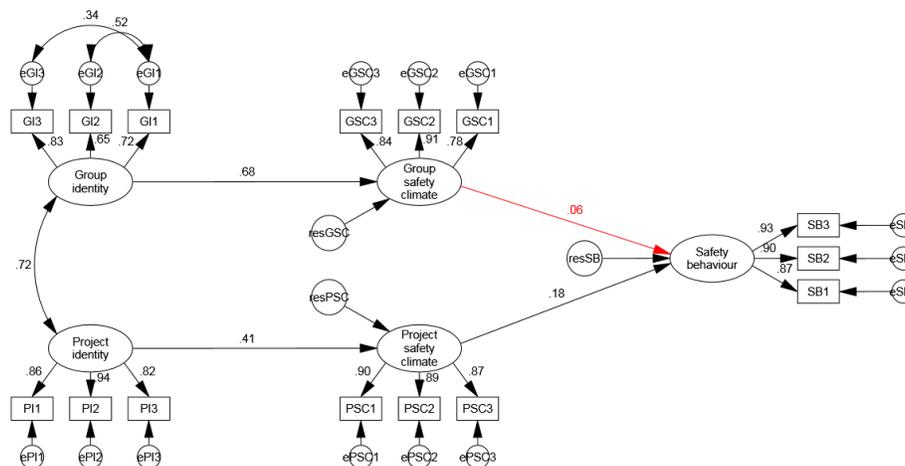


Fig. 3. Final structural model ( $\chi^2 = 157.91$ ;  $df = 83$ ; CFI = .968; RMSEA = .065)

## 5. Discussion and Conclusion

Social identity has implications for safety climate perceptions. At large construction sites many different social subgroups (e.g., concrete work crews) exist along with their peculiar values and goals, and different subgroups have different interpretations of safety rules, i.e., safety climate perceptions. This paper examines two types of social identity (i.e., group identity and project identity), and their associations with safety climate at two levels (i.e., work crew and project). Results show that group identity is positively associated with group safety climate while project identity is positively associated with project safety climate. Further, the association between social identity and safety climate is stronger at the work crew level than at the project level.

However, contrary to the hypothesis, group safety climate doesn't mediate the relationship between group identity and safety behavior. This indicates that crew leaders have not yet fulfilled their safety responsibility, and future interventions should make up for this deficiency.

The study is not without limitations. The biggest concern is the use of a cross-sectional design, which makes it difficult to draw causal inferences. Future research shall employ a longitudinal design to present a more comprehensive picture of the effects of social identity on safety behavior.

### Acknowledgement

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