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Structural Equation Model Analysis of Factors in the Spread of Unsafe Behavior among Construction Workers

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Abstract: To create a safe work atmosphere, it is essential to control the spread of unsafe behaviors among construction workers. Based on group behavior theory, the relationship between the influence factors and means of spreading unsafe behavior among construction workers is verified using a structural equation model (SEM) and multiround research data. According to the research, (1) spreading methods of unsafe behaviors consists of demonstration–imitation and infecting–conformity; (2) the influence of important figures, personal safety accomplishments, intensity of penalties for individual violations, and benefit-to-risk ratios of unsafe behaviors are correlated significantly with the spread of unsafe demonstration–imitation behaviors; and (3) the relational closeness of members, personal safety accomplishments, safety climate, and benefit-to-risk ratio of unsafe behaviors are correlated significantly with the spread of unsafe infecting–conformity behaviors.

Keywords: construction safety management; construction workers; unsafe behaviors; behavior spread; structural equation model

1. Introduction

Previous investigations have shown that frontline construction workers in China are mainly farmers with a poor overall level of education and a long tenure in a relatively closed occupational environment with a poor safety atmosphere. Accordingly, workers may learn unsafe behaviors from each other, resulting further in a rapid and extensive spread of unsafe behaviors within the group. Consequently, studying the basic rules and influence factors of the spread of unsafe behaviors among construction workers can help to control the evolution and propagation of unsafe behaviors, create a good safety climate, and reduce the number of accidents due to human factors.

The problem of unsafe behavior among construction workers has been a long-term focus in the construction safety management field. The latest research still focuses on the motivation, intention, and formation mechanism [1–3] of unsafe behaviors, process characteristics, and methods of intervention [4–9], etc. These studies are mainly based on individual behaviors, and seldom take interactions among workers and their impact on unsafe behaviors of the group into account. With the development of group behavior theory, issues of behavior spreading such as behavior imitation and conformity behavior within small groups similar to construction teams have drawn increasing attention [10–12]. Furthermore, the phenomenon of behavior spreading such as the imitation and learning of unsafe behaviors among construction workers in China has already been identified [13].

Therefore, after determining the mechanism of spreading unsafe behaviors among construction workers, structural equation modeling (SEM) is used here to verify the relationship between the influence factors and means of spreading unsafe behavior so as to restrain it much more effectively and create a robust safety climate.

2. Mechanism of Spreading Unsafe Behaviors among Construction Workers and Research Hypothesis

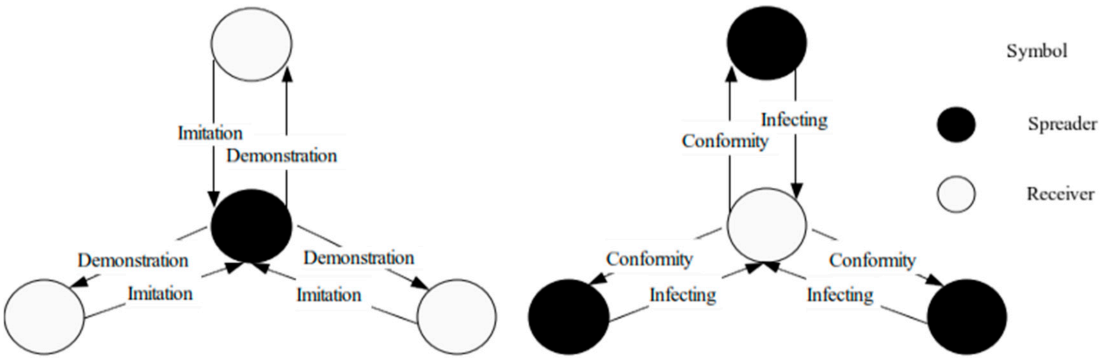
2.1. Mechanism of Spreading Behavior

To provide basic data and facts supporting this research, the authors launched a series of investigations (Table 1) through cluster random sampling and meticulously studied the reasons for unsafe behaviors among construction workers, the occurrence of typical unsafe behaviors, characteristics and rules of frequently occurring unsafe behaviors, features of safety cognition, and characteristic deviation of construction workers. This was done through semistructured and unstructured interviews, behavior observation, questionnaire surveys, etc., overcoming the distortion caused by "aversion" in traditional investigation methods. The construction site examined by interviews was located in a province in East China, and 829 workers, who are all frontline farmer construction workers, were interviewed. During this process, the phenomenon of the spread of unsafe behaviors among construction workers was discovered.

Table 1. Investigations of occupational safety and health among Chinese construction workers.

Code	Launch Time	Name of Investigation	Interviewees
Investigation 1	2014.7–2015.6	Investigation into the basic conditions of unsafe behaviors of construction workers	411
Investigation 2	2014.9–2015.6	Investigation into the group structural characteristics of construction workers	125
Investigation 3	2014.12–2015.8	Investigation into the income states and satisfaction of construction workers	83
Investigation 4	2015.3–2015.8	Investigation into the occupational safety and health conditions of painters in the construction industry	78
Investigation 5	2015.3–2015.8	Investigation into the occupational safety and health conditions of electric welders in the construction industry	106
Investigation 6	2015.6–2015.8	Investigation into habitual unsafe behaviors of construction workers	26

The spread of unsafe behaviors among construction workers mainly refers to the duplication, evolution, and spread of unsafe behaviors through worker interactions [14]. The above investigations discovered that construction workers in China work and live in a relatively closed group in which internal communication is more significant than external communication. Unsafe behaviors may be adopted by increasing numbers of workers through means such as poor example demonstration, adverse atmosphere infection, etc., and eventually lead to unsafe group behaviors. Therefore, it is considered that a special mechanism of spreading unsafe behaviors is formed within groups of construction workers (Figure 1) as follows.



(**a**) Demonstration–imitation (**b**) Infecting–conformity

Figure 1. Mechanisms of spreading unsafe behavior among construction workers.

The spread of unsafe behaviors through demonstration–imitation refers to workers who receive unsafe behaviors practicing the same or similar unsafe behaviors through behavioral imitation, having learned based on the behaviors demonstrated by the propagator. This includes two parallel processes (Figure 1a): behavioral demonstration by propagators and behavioral imitation by receivers. In practice, mentoring and self-study imitation are the primary methods of acquiring occupational skills by construction workers, but a substantial amount of unsafe behaviors are closely related to the specific work and skills. Consequently, it can be considered that behavioral demonstration and imitation can also spread unsafe behaviors. As shown in Investigation 1, 77% of workers acquired skills through mentoring and 23% through self-study imitation.

The spread of unsafe behaviors through infecting–conformity refers to receivers being 'infected' by the behavioral atmosphere created by propagators, where receivers then take up the same or similar unsafe behaviors due to group pressure and conformity psychology. This includes two parallel processes (Figure 1b), namely, the infection of receivers and conformity behaviors. Owing to the impacts of group closure and group pressure, the conformity psychology among construction workers is evidently stronger than that in other professions, and individual behaviors tend to be consistent. Therefore, it can be considered that behaviors of several propagators, the infection of the atmosphere created, and the conformity and behavior of receivers can spread unsafe behaviors. As shown in Investigation 1, 92% of workers insisted that they would be impacted significantly by the words and deeds of surrounding workers.

2.2. Research Hypothesis

Based on the above results, it was considered that a given factor can be taken as an influence factor when more than 50% of workers interviewed consider it to be influential or supported by various facts. Therefore, the specific hypotheses are as follows.

Influence of important figures: owing to the unified and concentrated relationship among construction workers, the words and deeds of important figures show an evident demonstration effect. As shown in Investigation 1, 78% of workers considered that the team leader is the person who has the greatest impact on them and who has the closest relationship with them; workers tend to imitate the team leader's behavior. A total of 90% of workers admitted that their safety cognition would be changed after contact with unsafe behaviors and their examples over a long term. Therefore, the spread of unsafe behaviors through demonstration–imitation exists among construction workers, from master to apprentice, from technical specialist to common workers, from experienced workers to new workers, etc. On this basis, H1 is proposed: the influence of important figures like the team leader and technical specialist is correlated significantly with the spread of unsafe behaviors though demonstration–imitation, and the stronger the influence is, the more evident the spreading effect.

Relational closeness among team members: owing to the strong group closure of construction workers and their close internal contact, members share similar demographic characteristics; thus, they present an evident effect of mutual influence. For instance, in Investigation 1, 74% of workers tended to work with their fellow townsmen. In Investigation 6, all workers admitted that their habitual safety violations are impacted by surrounding workers, showing conformity. On this basis, H2 is proposed: The relational closeness among workers is correlated significantly with the spread of unsafe behaviors through infecting–conformity. The closer the relationship among members, the more evident the spreading effect.

Personal safety accomplishments: owing to differences in safety skills, safety cognition, and accident experience of construction workers, workers' cognition of unsafe behaviors may not be identical in practice. For instance, in Investigation 1, 69% of workers who had already been working for more than 20 years indicated that they would not imitate specific targets directly. In Investigations 4 and 5, it was found that electric welders and painters from different teams showed distinct frequencies of not wearing safety devices, and one of the reasons for this was that individual and group accident experience and lessons resulted in different evaluations and cognitions of the same unsafe behaviors or of the level of danger for hazardous substances. Thus, H3a is proposed: personal safety accomplishment is correlated significantly with the spread of unsafe behaviors through demonstration–imitation. Moreover, H3b is proposed: personal safety accomplishment is correlated significantly with the spread of unsafe behaviors through infecting–conformity. The better the personal safety accomplishment, the more difficult it is for unsafe behaviors to spread.

Safety climate of the team: since construction workers mainly work and live within the team, safety climate factors such as the safety behaviors and practices of members, accidents, etc., have a major impact on the sense of personal safety and cognition. This was shown in Investigation 1, wherein 55% of workers indicated that they felt safer in construction teams free from accidents, and would not try dangerous behaviors. On the other hand, owing to the high group closure, the group atmosphere and pressure have a strong impact on the behavior and psychology of construction workers. Therefore, infecting–conformity exerts a stronger effect in the spread of unsafe behaviors among construction workers than in other occupational teams. In Investigations 4 and 5, many workers indicated that the reason they refuse to use protective devices is that they find that surrounding workers were not injured or punished for not using the devices; accordingly, they think it is unnecessary to use these devices. Therefore, H4 is put forward: A safe climate is correlated significantly with the spread of unsafe behaviors through infecting–conformity. The better the safety climate, the more difficult for unsafe behaviors to spread through infecting–conformity.

Intensity of penalties for individual violations: positive safety education may not achieve significant effects among construction workers; instead, strict punishments may be more effective. For instance, in Investigation 6, 87.5% of workers indicated that they were afraid of strict punishments such as high penalties, dismissal, etc. However, owing to the belief that the law does not punish numerous offenders, punishment exerts a limited effect in inhabiting unsafe behaviors. In Investigation 6, 75% of workers showed that they were not afraid of punishment if most workers break rules and regulations. Thus, H5 is proposed: The intensity of the penalty for individual violations is correlated significantly with the spread of unsafe behaviors through demonstration–imitation. The stronger the intensity of punishment, the more difficult it is to spread unsafe behaviors through demonstration–imitation.

The benefit-to-risk ratio of unsafe behaviors: owing to the danger of unsafe behaviors, workers evaluate the benefit-to-risk ratio when choosing whether to adopt them. Unsafe behaviors of low risk, easy practice, and evident profit are spread much more easily; for instance, in Figure 1, 68% of workers indicated that they may imitate behaviors which are of low safety but which can enhance work performance. In Investigation 6, 62.5% of workers indicated that they would practice unsafe time-saving and labor-saving behaviors during busy hours, in heavy tasks, and under fatigue. Therefore, H6a is proposed: the higher the benefit-to-risk ratio of an unsafe behavior, the more easily it is spread.

3. Research Design and Methods

Based on the above assumptions, this study is supported by a Structural Equation Model (SEM). Compared with the traditional statistical analysis methods, this method has the following characteristics and advantages: (1) Variables that are difficult to measure directly can be measured using this method. The two important variable types of a structural equation model are latent variables and observed variables. Latent variables are variables that are difficult to measure directly. Observational variables are variables that can be directly measured. A latent variable is usually decomposed into multiple observed variables, and the change of latent variables is reflected by measuring the observed variables. Some variables that are difficult to measure directly or are more sensitive can be analyzed using the structural equation model; (2) Multiple variables can be analyzed. When the relationship between variables is studied, it is not enough to consider only the correlation between variables, but also the relationship between the relevant elements. However, it is difficult to deal with these problems using traditional statistical methods. Structural equation modeling can solve problems with many variables, especially when the variables themselves have errors. Structural equation modeling allows independent variables and dependent variables to have measurement errors, and multiple variables can be analyzed at the same time. Therefore, this method can well meet the research needs.

Based on the research results, related articles, and engineering data, the authors compiled a questionnaire concerning the relation between influence factors and the spread of unsafe behaviors. In the research, 280 questionnaires were dispatched and 246 were recovered. All interviewees were frontline constructions workers. In the analysis stage, SPPS 17.0 software was applied for the reliability and validity test, while AMOS 17.0 was applied for the analysis and verification of significant correlations.

From Table 2, the Cronbach's α values of variables in all dimensions were more than 0.7, so the questionnaire showed good validity. The KMO (Kaiser-Meyer-Olkin) reached 0.816 > 0.7, and the Bartlett test result was significant, suggesting that the data were suitable for exploratory factor analysis.

Table 2. Rotated component matrix (influence factors).

Contents	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
X1 Authority and influence of the team leader						0.787
X2 Professional skills and influence of technical specialists						0.840
X3 Safety behaviors and influence of safety model						0.803
X4 Task similarity among workers		0.668				
X5 Skill similarity among workers		0.760				
X6 Cultural consistency among workers		0.825				
X7 Personal similarity among workers		0.738				
X8 Safety knowledge level of workers	0.901					
X9 Safety skill level of workers	0.887					
X10 Safety consciousness level of workers	0.887					
X11 Compliance with safety rules among team members				0.800		
X12 Safety activity involvement of team members				0.876		
X13 Frequency of safety accidents within the team				0.786		
X14 Intensity of economic punishment of individuals					0.819	
X15 Intensity of labor punishment on individuals					0.790	
X16 Intensity of system punishment on individuals					0.831	
X17 Time revenue of unsafe behaviors			0.867			
X18 Labor revenue of unsafe behaviors			0.871			
X19 Process experience of unsafe behaviors			0.842			
Cronbach's α	0.921	0.785	0.857	0.823	0.841	0.807
Variance interpretation rate %	13.917	12.987	12.739	12.117	12.077	11.474
Accumulated variance interpretation rate %	13.917	26.904	39.643	51.760	63.837	75.312
KMO value	0.816					
Bartlett test chi-square value	2384.336					
p value	0.000					

Factors were extracted using principal component analysis; according to the results, six factors whose characteristic roots were more than 1 were extracted, and the factor rotation adopted the maximum variance method. The interpretation rate of the cumulative variance of six factors reached 75.312%, over 50%, and the load of all factors was more than 0.5. Furthermore, the rotated factor structure and entry distribution also met the theoretical expectations of the research. Consequently, influence factors showed good construct validity.

From Table 3, the Cronbach's α values of variances in all dimensions were more than 0.7, so questionnaires showed good validity. The KMO was 0.739 > 0.7, and the Bartlett test result was significant, suggesting that the data were suitable for exploratory factor analysis.

Table 3. Rotated component matrix (spreading methods).

Item	Factor 1	Factor 2
X20 Observation of workers and spreading of unsafe behaviors	0.876	
X21 Imagination of workers and spreading of unsafe behaviors	0.865	
X22 Communication between workers and spreading of unsafe behaviors	0.877	
X23 Group atmosphere and spreading of unsafe behaviors		0.847
X24 Group pressure and spreading of unsafe behaviors		0.906
Cronbach's α	0.862	0.745
Variance interpretation rate %	47.165	32.271
Cumulative Variance interpretation rate %	47.165	79.436
KMO value	0.739	
Bartlett test chi-square value	492.659	
p value	0.000	

Factors were extracted using principal component analysis; according to the results, two factors whose characteristic roots were more than 1 were extracted, and the factor rotation adopted the maximum variance method. The cumulative interpretation rate of the two factors reached 79.436%, over 50%, and the load of all factors was more than 0.5. Furthermore, the rotated factor structure and entry distribution also met the theoretical expectation of the spreading mechanism in this research. Consequently, the spreading method showed good construct validity.

4. Model Verification

Factors impacting the spread of unsafe behaviors among construction workers consist mainly of internal and external factors, and the spreading mechanisms include demonstration–imitation and infecting–conformity. On the premise of not impacting the accuracy of research results, the authors established a fitting path for the internal and external factors and for demonstration–imitation and infecting–conformity types, respectively. Hence, four SEM models were constructed, as shown in Figures 2–5.

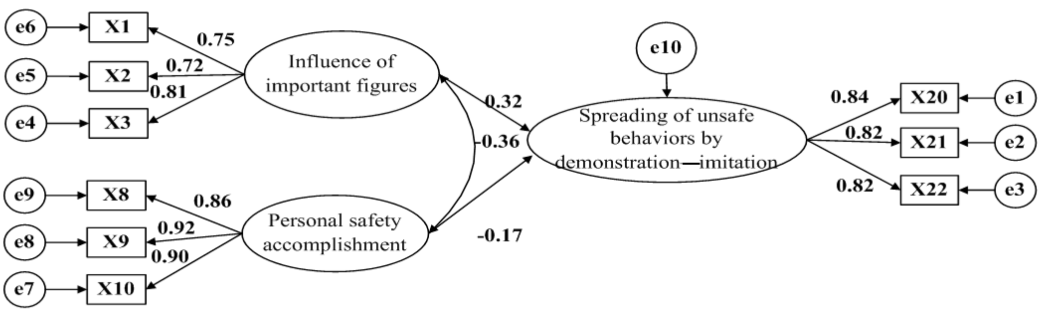


Figure 2. Structural Equation Model (SEM) of the relationship between internal factors and the demonstration–imitation mechanism.

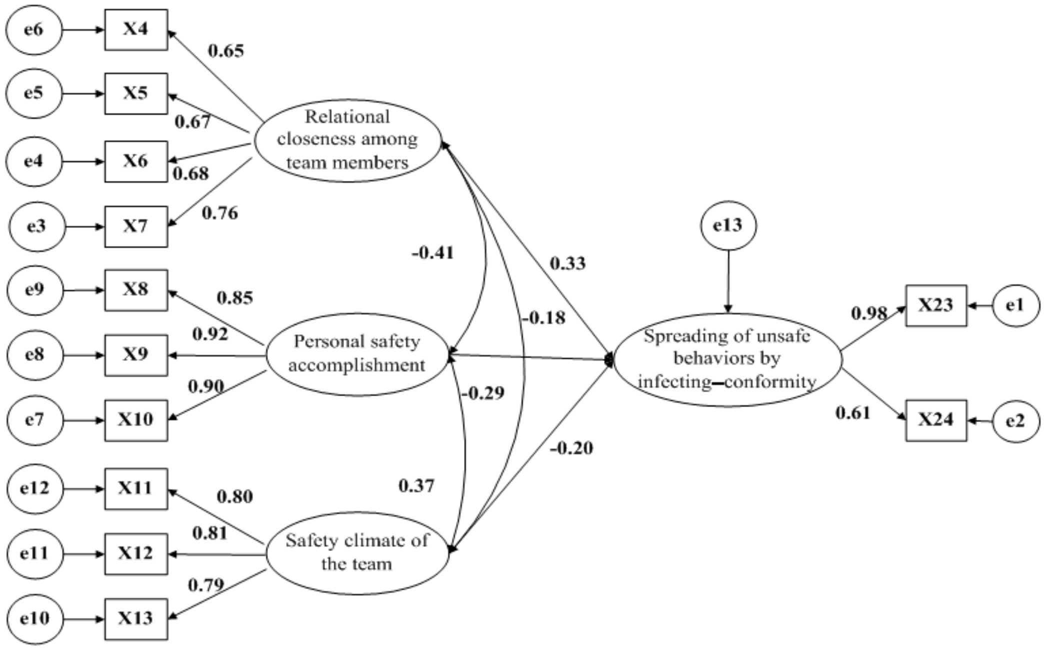


Figure 3. SEM of the relationship between internal factors and the infecting–conformity mechanism.

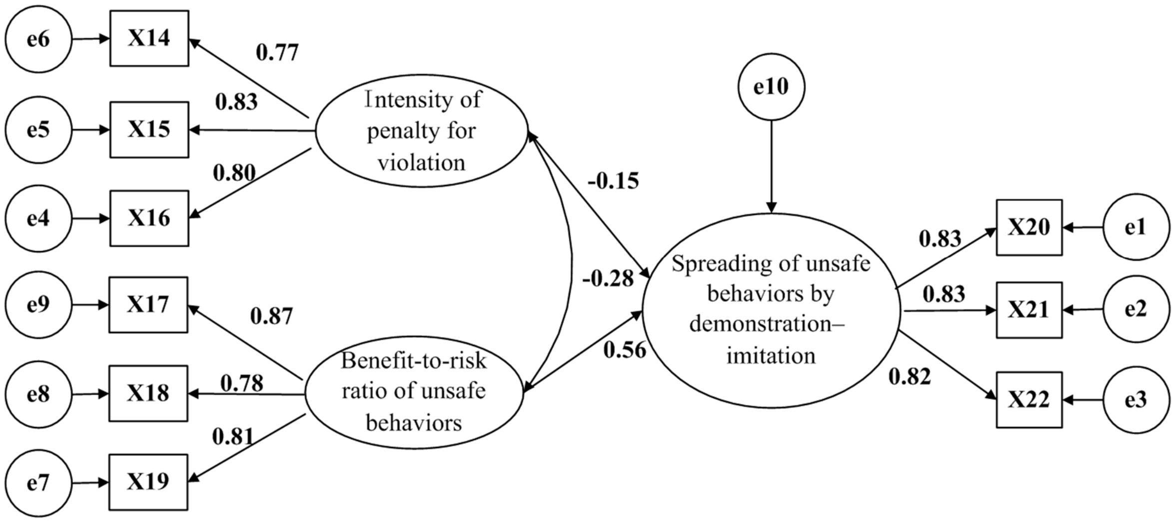


Figure 4. SEM of the relationship between external factors and the demonstration–imitation mechanism.

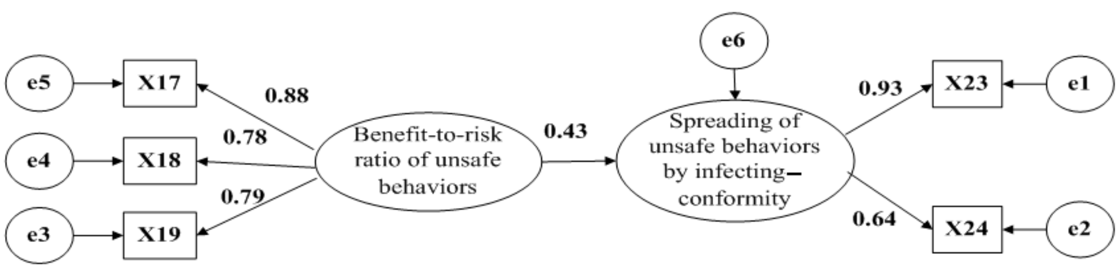


Figure 5. SEM of the relationship between external factors and the infecting–conformity mechanism.

It should be noted that the chi-square test of goodness of fit (χ^2 goodness-of-fit test) is the most frequently reported goodness-of-fit indicator, and the probability of the correctness of the model can be given by using χ^2 goodness-of-fit test together with the degree of freedom. The value χ^2/df is the statistic which can directly test the degree of similarity between the sample covariance matrix and the estimated variance matrix, and the theoretical expectation is 1. The closer χ^2/df is to 1, the better the fitting is. In the actual study, when χ^2/df is close to 2, the fitting of the model is good, and when the sample is large, about 5 is acceptable. The comparative fit index (CFI) is obtained at the time of comparison between the hypothetical model and the independent model, and its value was between 0 and 1. The closer it was to 0, the worse the fitting is, and the closer it was to 1, the better the fitting is. It is generally believed that, when CFI $\geq$ 0.9, the model fits well. The Tucker–Lewis index (TLI) is a comparison of fit index, and the value is 0–1. The closer it is close to 0, the worse the fitting is, and the closer it is to 1, the better the fitting is. If TLI > 0.9, then the model fits well. The root-mean-square error of approximation (RMSEA) is an index that represents the degree of not fitting. If it is close to 0, the fitting is good. On the contrary, the farther away from 0, the poorer the fit is. It is generally believed that if RMSEA = 0, the model is completely fitting; if RMSEA < 0.05, the model is close to fitting; if 0.05 $\leq$ RMSEA $\leq$ 0.08, the model is fitting well; if 0.08 < RMSEA < 0.10 the model is fitted generally; if RMSEA $\geq$ 0.10, it indicates poor fitness.

In Figure 2, χ^2/df = 1.104, CFI = 0.998, TLI = 0.997, and RMSEA = 0.021; the path fitting was good, and the model was accepted. The standardized regression coefficient of the influence of important figures on the spread of unsafe behaviors through demonstration–imitation was 0.316, t = 3.898, and $p < 0.05$, proving H1, while the standardized regression coefficient of personal safety accomplishment was -0.165, t = -2.232, and $p < 0.05$, verifying H3a.

In Figure 3, χ^2/df = 2.084, CFI = 0.962, TLI = 0.948, and RMSEA = 0.067; the path fitting was good, and the model was accepted. The standardized regression coefficient of the relational closeness among team members on the spread of unsafe behaviors through infecting–conformity was 0.333, t = 4.410, and $p < 0.05$, proving H2; while that of personal safety accomplishment was -0.180, t = -2.576, and $p < 0.05$, proving H3b; and that of the team safety climate was -0.196, t = -2.796, and $p < 0.05$, verifying H4.

In Figure 4, χ^2/df = 2.276, CFI = 0.972, TLI = 0.958, and RMSEA = 0.072; the path fitting was good, and the model was accepted. The standardized regression coefficient of the intensity of penalties for safety violations on the spreading of unsafe behaviors through demonstration–imitation was -0.154, t = -2.287, and $p < 0.05$, proving H5; and that of the benefit-to-risk ratio of unsafe behaviors was 0.556, t = 7.477, and $p < 0.05$, verifying H6a.

In Figure 5, χ^2/df = 0.572, CFI = 1.000, TLI = 1.009, and RMSEA was close to 0; the path fitting was good, and the model was accepted. The standardized regression coefficient of the intensity of penalties for violations to the spreading of unsafe behaviors through infecting–conformity was 0.433, t = 6.024, and $p < 0.05$, verifying H6b.

5. Result Analysis and Discussion

The influence of important figures, personal safety accomplishment, intensity of penalties for violations, and benefit-to-risk ratios of unsafe behaviors were in significant correlation with the spreading of unsafe behaviors through demonstration–imitation. Meanwhile, the relational closeness among team members, personal safety accomplishment, and benefit-to-risk ratios of unsafe behaviors were in significant correlation with the spreading of unsafe behaviors through infecting–conformity.

The benefit-to-risk ratios of unsafe behaviors have significant positive impact on the two spreading mechanisms, suggesting that the potential benefit of unsafe behaviors is a key factor taken into account by workers while they adopt these behaviors; this is consistent with the investigation results. As shown in Investigation 3, workers indicated that they realize the danger of some trouble-saving behaviors, but that, nevertheless, the only objective is to work more and increase their income. Therefore, opportunistic low-danger unsafe behaviors are spread easily, and more attention should be focused on them. The above investigations also show that, with the improvement of safety consciousness of workers, some dangerous unsafe behaviors gradually disappear but some less dangerous unsafe behaviors occur frequently and even become habitual. For instance, in Investigation 6, 67% of workers indicated that less dangerous unsafe behaviors receiving lax punishments are more attractive. On the contrary, to decrease the benefit-to-risk ratios of unsafe behaviors would prevent the spreading of unsafe behaviors significantly. In Investigation 1, 96% of workers said that they would firmly refuse unsafe behaviors after witnessing the consequences of accidents.

The influence of important figures has a significant positive impact on the spreading of demonstration–imitation unsafe behaviors. This suggests that construction workers in China tend to observe and imitate others' behaviors to acquire new behaviors owing to their special means of skill acquisition and cognitive rules. This also results in the fact that important figures play a strong leading and demonstrating role among other workers, especially among new workers. For instance, in Investigation 1, 89% of workers with less than five years of experience believed that the main approach for acquiring and improving skills involves observing and imitating the behaviors of masters and technical specialists. In Investigations 4 and 5, workers indicated that whether they would use protective devices or whether they would apply them correctly is mainly learned from instructions and demonstrations of masters. Therefore, attention should be paid to the demonstration effects of team leaders and technical specialists.

Personal safety accomplishment has a significant negative impact on the two spreading mechanisms, suggesting that improving the knowledge of personal safety, skills, and consciousness of construction workers would help fundamentally to prevent the spread of unsafe behaviors. The above investigations found that married workers with heavy burdens worked carefully with good safety consciousness, and they expressed that they would not take up unsafe behaviors blindly by following others. However, at present, most workers would underestimate and even fail to realize the danger of some unsafe behaviors because they rely on their intuitive judgments and perceptual knowledge of the dangers involved. For instance, in Investigation 1, 60% of workers indicated that a behavior would be safe if it leads to no accidents, which reflects the urgency of improving personal safety accomplishment and perception of danger.

Intensity of penalties for safety violations has a significant negative impact on the spread of demonstration–imitation unsafe behaviors, suggesting that punishment is an effective approach in prohibiting the spread of unsafe behaviors. However, frontline construction workers are less educated, and owing to strong occupational mobility, workers lack sufficient time and opportunities to accumulate adequate safety knowledge and experience. Traditional safety education then fails to achieve an actual effect. For instance, in Investigation 1, only 7% of workers thought that safety education is of great help. Consequently, the simple approach of forbidding certain behaviors is more effective. However, construction workers usually work in a disperse way, presenting strong mobility, and safety management relies mainly on self-supervision; workers even share the outlook that the law does not punish numerous offenders. Consequently, this method achieves a better effect in prohibiting the spreading of unsafe behaviors through demonstration–imitation dominated by individual behaviors. In addition, H6a and H6b, verified already, also show that reducing the benefit-to-cost ratios of unsafe behaviors by enhancing the intensity of penalties (i.e., the costs) for safety violations would prohibit the spread of unsafe behaviors.

Relational closeness among team members has a significant positive impact on the spread of unsafe behaviors through infecting–conformity; meanwhile, the safety climate of the team has a significant negative impact. Actually, the two factors are closely related as two sides of one idea: in a team with a good safety climate, the higher the relational closeness, the less unsafe behaviors can be spread through infecting–conformity since construction workers in China exhibit high structural and relational closeness. This may explain why this group shows more assimilation and conformity behaviors than other occupational groups. Moreover, construction workers in the same team are usually relatives and friends, relying strongly on each other, and they may develop a conformity psychology and take unsafe behaviors. In addition, closed groups feature high group pressure, and workers may remain for a long period of time in an 'immersed' behavior-spreading environment and take up some unsafe behaviors unconsciously. Therefore, a good safety climate is favorable for prohibiting the spread of unsafe behaviors through infecting–conformity, and relational closeness among team members is a catalyst in spreading unsafe behaviors through infecting–conformity.

6. Conclusions

This study investigated the spread of unsafe behaviors among construction workers in terms of the mechanisms involved. The following conclusions were drawn.

(1) The spread of unsafe behaviors of construction workers refers to the duplication, evolution, and propagation of unsafe behaviors through worker interactions, and the spreading mechanisms include demonstration–imitation and infecting–conformity.

(2) The benefit-to-risk ratios of unsafe behaviors are an important factor taken into account by workers while they adopt these behaviors; the higher the benefit-to-risk ratio, the more easily an unsafe behavior can be spread.

(3) Improving personal safety accomplishment is a fundamental approach in preventing the spread of unsafe behaviors; however, owing to factors such as culture, concept, etc., it is difficult to improve the personal safety accomplishment of construction workers in China within a short period of time.

(4) The influence of important figures and the intensity of penalties for safety violations are correlated significantly with the spread of unsafe behaviors. Focusing on the demonstration effect of team leaders and technical specialists, controlling typical unsafe behaviors and enhancing the intensity of penalties for safety violations would create a 'warning effect' and significantly prohibit the spread of unsafe behaviors through demonstration–imitation.

(5) Relational closeness and safety climates are correlated significantly with the spread of unsafe behaviors through infecting–conformity. A good safety climate would be favorable for prohibiting the spread of unsafe behaviors through infecting–conformity, and the relational closeness of team members is a catalyst in spreading unsafe behaviors through infecting–conformity.

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Author Contributions: Yu Han conceived and designed the investigations; Hui Jiang and Yu Han performed the investigations and analyzed the data; Jianping Wang and Huiguang Yin gave some important suggestions; Hui Jiang wrote the paper.

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