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How Can Conflicts with Supervisors or Coworkers Affect Construction Workers' Safety Performance on Site? Two Cross-Sectional Studies in North America

Yuting (Tina) Chen [1,*], Douglas Hyatt [2], Arash Shahi [3], Awad Hanna [4] and Mahdi Safa [5]

[1] Engineering Technology and Construction Management, University of North Carolina at Charlotte, Charotte, NC 28223, USA
[2] Rotman School of Management, University of Toronto, Toronto, ON M5S 1A4, Canada; doug.hyatt@rotman.utoronto.ca
[3] AECO Innovation Lab, Richmond Hill, ON L4B 4V1, Canada; arash@aecoinnovationlab.com
[4] Civil and Environmental Engineering, University of Wisconsin-Madison, Madison, WI 53706, USA; ashanna@wisc.edu
[5] Civil and Environmental Engineering, University of Houston, Houston, TX 77204, USA; msafa@central.uh.edu
* Correspondence: ychen106@charlotte.edu

Abstract: A safety plateau in the construction industry has been reported in the US and Canada, which has prompted researchers to seek new factors affecting construction safety performance. Tapping into advancements in the theory of human and organizational behaviors can yield valuable new perspectives. Therefore, by leveraging the advancement of the Job Demand Control Support model in the field of occupational safety and health, this paper firstly tested the impact of one newly added hindrance stressor (i.e., interpersonal conflicts on construction sites) by researchers on organizational behaviors on the safety performance of construction workers, based on two cross-sectional studies in the US and Canada. Differentiations were made between conflicts with supervisors and conflicts with coworkers. One personal resource factor, i.e., individual resilience, was also considered in this paper. A "causal" chain that shows the mitigation impact of individual resilience on conflicts with supervisors or coworkers, and the adverse impact of conflicts with supervisors or coworkers, on unsafe events were found to hold true for both US and Canadian construction sites, based on the results from measurement invariance tests and structural equation modelling. Recommendations regarding how to improve construction workers' individual resilience and reduce interpersonal conflicts on site, thereby reducing safety incidents on site, are provided.

Keywords: job demand control support model; hindrance stressors; interpersonal conflicts at work; construction safety

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1. Introduction

Construction safety performance has improved substantially in the past four decades. For example, the fatality rate in the US construction industry decreased from 23 per 100,000 workers to 14 per 100,000 workers between 1980 and 2020 [1,2]. However, a plateau in the reduction of safety incidents has recently been reported in several countries, such as the US and Canada. This has prompted researchers to seek new factors affecting construction safety performance and to improve the response and adaptation abilities of both individuals and organizations when facing safety issues. In particular, tapping into advancement in the theory of human and organizational behaviors could yield valuable new perspectives.

The Job Demand Control Support (JDCS) model has been very popular in the occupational safety [3,4] and health field [5,6]. Recently, Dawson et al. [7] innovatively altered the JDCS model by incorporating three hindrance stressors including interpersonal conflicts at work (ICW), role conflict, and organizational politics, in addition to two challenge stressors including job demands and quantitative workload. Hindrance stressors are the stressors appraised as thwarting goal attainment and challenge stressors are those appraised as potentially promoting growth and achievement [8]. The work by Dawson et al. [7] is indeed one significant advancement of the traditional JDCS model. However, few studies have linked the above three hindrance stressors (i.e., ICW, role conflict, and organizational politics) to safety and health issues in the construction industry, despite efforts from researchers in the construction field [9–16].

To bridge this gap, this paper aims to show how one hindrance stressor (i.e., ICW) can affect construction workers' safety performance via two cross-sectional studies in Canada and the US. ICW can be defined as negative interactions with others on construction sites [17], such as rude attitudes from coworkers or supervisors. In addition, individual resilience (IR) that is related to a person's positive personality when facing adverse events is also considered in this paper. IR, which is a significant component of psychological capital, is proposed as a personal resource in the framework of JDCS for construction workers [11]. Interactions among IR, ICW, and the safety performance of construction workers are explored in this paper, which shows how personal resources and hindrance stressors from the work environment work together to affect construction workers' safety performance.

This paper is organized as follows. Section 2 provides a comprehensive review of the relevant literature, while Section 3 outlines the materials and methods employed in the study. Section 4 presents the obtained results, and Section 5 delves into a detailed discussion of these findings. Finally, Section 6 encapsulates the conclusions drawn from the study.

2. Literature Review

Job hindrances are threatening constraints, which deplete employees' energy and elicit an emotion-focused coping style. Job challenges are obstacles that can be overcome. They require energy but are simultaneously stimulating [18]. This section reviews previous studies on the three hindrance stressors (i.e., ICW, role conflict, and organizational politics) and the two challenge stressors (i.e., job demand and quantitative load).

Ongoing conflict at work has been found to be significantly related to poor general health [19]. Recently, there have been several studies in the context of the healthcare sector. For example, Palancı et al. [20] found a significant negative relationship between ICW and workplace health in the healthcare sector of Turkey. Lavelle et al. [21] found that hospital team performance was predicted by low interpersonal conflict at work based on data from hospitals in London. However, very few studies on ICW in the construction industry have been conducted. To the best knowledge of the authors, only Chen et al. [22] found significant positive relationships between ICW and physical injuries and unsafe events of Canadian construction workers.

Role conflict occurs when an employee faces inconsistency or incompatibility in the demands and expectations of various parties that cannot be satisfied at the same time [23]. This means that the employees who have to work with two or more groups that operate quite differently and/or receive incompatible requests from two or more people would have increased role conflict levels [24]. Role conflict has been linked to the mental health challenges of employees. For example, Dodanwala et al. [24] found that role conflict is positively related to the increased job stress of construction workers in Sri Lanka. Schmidt et al. [25] found a significant positive relationship between role conflict in the workplace and depression. Moreover, Hazeen Fathima and Umarani [26] found a significant positive relationship between role conflict and intention to leave in Indian construction firms.

Organizational politics is a pervasive workplace phenomenon and reflects the political climate in an organization [27]. It involves the activities, behaviors, and strategies that individuals within an organization use to gain power, influence, and achieve personal or group objectives. As a situational variable, perceptions of organizational politics (POP) involve an individual's interpretation of behaviors driven by self-serving motives and an individual's subjective assessment of the degree to which the work environment is characterized by co-workers and supervisors exhibiting such self-serving behavior [28]. Recently, organizational politics has been linked to psychological safety, voice behavior, work engagement, and compulsory citizenship behavior. Psychological safety is the belief that exhibiting risky behaviors, such as voice, will not cause personal harm [29]. For example, Li et al. [30] found POP is negatively associated with psychological safety, and psychological safety mediates the negative relationship between organizational politics, as perceived by employees, and their voice behavior. Silva de Carvalho Chinelato [31] found that organizational-level psychological safety and an employee-level perception of organizational politics predicted employee work engagement, and organizational-level psychological safety benefits the work engagement of individuals more when they perceive the existence of low organizational politics. Alkan and Turgut [32] found that organizational political perceptions have an impact on compulsory citizenship behavior that assumes that organizational citizenship behavior (OCB) is exhibited by immediate supervisor, management, or coworker pressure rather than voluntarism. OCB refers to discretionary, nonrequired contributions by members to the organizations that employ them. Evidence indicates that job satisfaction is more closely related to such contributions than to productivity in core job tasks [33].

Job demand refers to the workload and the cognitive and emotional requirements of a job. It encompasses the amount of work to be done, the complexity of the tasks, and the time pressure involved, e.g., whether a worker has time to do the work [34]. Quantitative workload refers to the volume and amount of work an individual is expected to handle within a specific time frame [35]. For example, how often a job requires a worker to work very fast or work very hard. Quantitative workload is highly related to job demand but focuses on a quantitative measure. There have been some research studies focusing on the job demands or workloads of construction workers. For example, job demand has been linked to construction workers' injury severity [36]. Lee et al. [37] found a significant positive relationship between physical task demand measured by heart rate and the exhaustion of construction workers in a lab environment.

To summarize, little research has been conducted on ICW and organizational politics in the context of construction, with a fair number of studies on role conflict, job demand, and quantitative workload. This paper only focused on ICW.

3. Materials and Methods

A self-administered questionnaire was used in this research. Two types of ICW including interpersonal conflicts with supervisors (ICWs) and interpersonal conflicts with coworkers (ICWc) were differentiated. The questionnaire was distributed to Canadian and US construction sites. In total, 771 valid questionnaires were collected from Canadian construction sites and 385 valid ones were collected from US construction sites.

3.1. Survey Instrument

The self-administered questionnaire comprised demographics (e.g., job tenure), questions to measure IR, ICWs, ICWc, and a reporting section of unsafe events (e.g., frequency of the unsafe event "trapped by something"). The questionnaire was adapted from previous surveys by [22,38]. A Likert scale between 1 (strongly disagree) and 5 (strongly agree) was used to measure IR, while a frequency scale of never, rarely, sometimes, quite often, and very often was used for ICWs and ICWc. For the unsafe events reporting section, questionnaire respondents were asked how frequently they experienced unsafe events on site in the 3 months prior to the survey. A frequency scale of none, once, 2–3 times, 4–5 times, and more than 5 times was used for the unsafe events reporting.

3.2. Data Collection and Participants

Convenience sampling was used in this research. A fully strict survey collection procedure was employed for both Canada and US data. For example, a consent form was used, and the questionnaire was strictly anonymous. When recruiting sites, a top-down and bottom-up approach was used, i.e., the research team recruited top management of construction companies to obtain their support for the site visit, and visited sites locally first then obtained the approval of site visits from top management. Research assistants were hired to distribute the questionnaire to workers on site after scheduling a site visit time with the site supervisors. No monetary incentives were used, while construction workers were provided a sports drink and a hardhat sticker as appreciation for their time. For all the site visits, when scheduling the site visit time, the research assistants requested an expected number of workers on site for the survey, based on which printed surveys were prepared. Approximately 75% of the expected number of workers on site filled in the survey.

Table 1 shows the demographic information of the respondents from the Canadian and US construction sites. The average age of the Canadian respondents was 37, almost 2 years younger than the US respondents. Canadian respondents had 14 years of experience on average, and US respondents had 15 years of experience. The respondents had been employed by their current employers for approximately 6 years on average for both samples. US respondents reported relatively higher mobility between projects and longer weekly working hours than the Canadian respondents. On average, both US and Canadian respondents reported having 2 employers in the previous 3 years. As expected, a very high safety training percentage was reported. Approximately 38% of Canadian respondents and 28% of US respondents reported serving as a safety committee member. Approximately 60% and 57% of respondents belonged to a labor union for the Canada and US, respectively. In both samples, more than 80% of the respondents were supervisors or journeymen with apprentices making up less than 20% of the sample.

Table 1. Participants' demographics comparison.

Demographics	**Canada**	**US**
Gender	98% male	96% male
Age	37	39
Years in the construction industry	14	15
Years with current employers	6	6
No. of employers in the previous 3 years	2	2
No. of projects in the previous 3 years	10	17
Average weekly work hours	44	45
Safety training percentage	98%	96%
Safety committee member percentage	38%	28%
Union member percentage	60%	57%
Job position	Supervisor 31% Journeyman 51% Apprentice 18%	Supervisor 20% Journeyman 61% Apprentice 19%

3.3. Measures

Five questions were used to measure IR [39,40]; an example question was "I am confident that I could deal efficiently with unexpected events". The coefficient alpha of the scale was 0.83 and 0.82 for Canada and US sample, respectively. ICWs and ICWc were measured by three questions for each [35]. The questions asked about the frequency of the respondents getting into arguments with their coworkers and supervisors, and how often their coworkers or supervisors did nasty or mean things to them. High scores represented frequent conflicts with others. The internal consistence alpha of ICWs was 0.85 and 0.84 for

Canada and US sample, respectively. The internal consistence alpha of ICWc was 0.81 and 0.78 for Canada and US sample, respectively.

3.4. Hypotheses

IR is about a person's positive psychological capacity for performance improvement [41], which may help construction workers control or prevent adverse events, e.g., conflicts with others or unsafe events on construction sites. Conflicts with others in the workplace, by contrast, may increase the probability of the occurrence of unsafe events on construction sites. For example, if a worker has conflicts with his/her coworkers, then his/her work may be negatively affected when his/her coworkers refuse to provide help or cooperation related to the safety side of the work, e.g., making sure the site is always clean and organized. Therefore, the following hypotheses were made in this paper:

H1. *IR has a negative relationship with ICWs across Canada and US;*

H2. *ICWs has a positive relationship with ICWc across Canada and US;*

H3. *IR has an indirect negative relationship with ICWc via ICWs across Canada and US;*

H4. *ICWc has a positive relationship with unsafe events across Canada and US.*

3.5. Data Analysis

The statistical analyses were performed using R version 4.3.2. Since some comparisons were made between Canadian and US samples, measurement invariance (MI) tests were conducted before any comparison could be made. MI examined whether members of different cultures interpret a measure in a conceptually similar way [42]. MI tests were achieved using a multi-group confirmatory factor analysis (MGCFA) with the Lavaan package in R. MGCFA includes four sub-steps [43,44], where equalities were placed on various item parameters with increasing constraints: configural invariance, weak invariance, strong invariance, and strict invariance.

The first step (Figure 1) of MGCFA is configural invariance test. A confirmatory factor analysis (CFA) for each sample was run to determine whether Canada and US sample holds the same factor structure, i.e., the same number of latent variables (LVs) formed by the same number of indicator variables. In this paper, a 3-factor model was the best for both samples, which provides a possibility for the remaining steps. In this step, there was no requirement that estimated coefficients were equal across the two groups, but the price for these weak assumptions was that there was no reason to believe that the LVs were measuring the same construct in each group.

Once configural invariance held, the weak invariance test was conducted. This level added that, for a given indicator, the loadings were the same across groups. Then, the strong invariance test was conducted. This level of invariance added the constraint that, for a given indicator variable, the intercepts were the same among groups. Moreover, strong invariance allowed for comparisons of the LVs. Specifically, latent means, variances, and covariances could all be compared among groups. Finally, a strict invariance test was conducted. This level added that, for a given indicator, the error variances were equal across groups.

Internal-consistency reliability tests were also conducted for each sample to show how well questions of a factor reflected a common, underlying construct. Then factor means and correlations of the studied variables were analyzed. At last, structural equation modeling (SEM) techniques were used to examine the relationships between IR, ICWS, ICWC, and unsafe events.

The fit indices used for SEM included an overall fit statistic χ^2, the relative χ^2 (i.e., χ^2/degrees of freedom), comparative fit index (CFI), and root mean square error of approximate (RMSEA), following [42]. Although χ^2 is very sensitive to sample size, it should be reported along with its degree of freedom and associated p value [46]. The relative χ^2 (i.e., χ^2/degrees of freedom) [47] can address the sample size limitation, and thus it was used. A suggested range for the upper bound of this statistic is between 2 [48] and 5 [47]. CFI values greater than 0.95 have been suggested [49], but CFI values greater than 0.90 are deemed acceptable. RMSEA is regarded as one of the most informative fit indices [50,51]. In a well-fitting model, its value range is suggested to be from 0 to 0.08 [49,52].

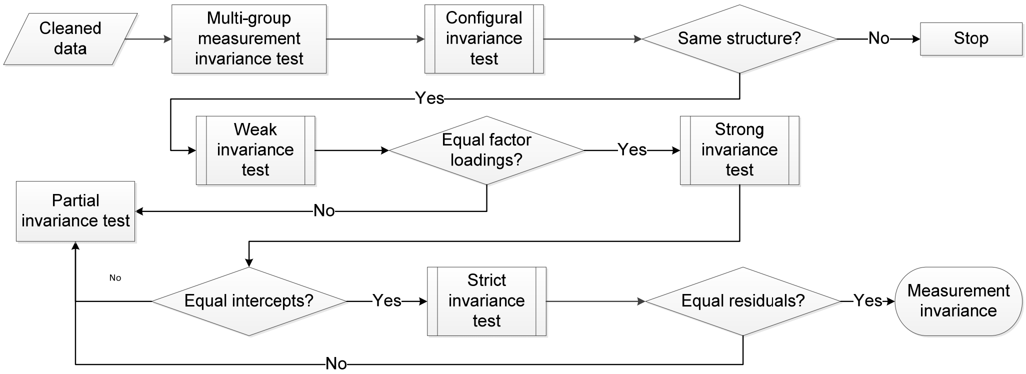

Figure 1. Steps of MI tests [45] (With permission from ASCE, reference [45] can be reused in this paper in accordance with its Rights and Permissions policy.).

4. Results

4.1. Examination of Factor Structure

Within-group tests of the three-factor measurement model were conducted for each sample [45]. Table 2 shows the model fit statistics, which supports that the three-factor model has the best fit. The hypothesized three-factor model was compared with a one-factor model and a two-factor model for each sample. For the one-factor model, all the 11 indicator variables formed into a single factor. For the two-factor model, three indicator variables of ICWs and three indicator variables of ICWc formed into a single factor, and five indicator variables of IR formed into the other factor. Both alternative competing models are nested in the proposed three-factor model, so we compared the hypothesized three-factor model with each of the two competing models based on the Chi-square difference (χ^2 diff) associated with the models. The χ^2 difference follows a χ^2 distribution. For instance, for the Canada sample, the χ^2 value of the hypnotized three-factor model was 148.58 with a degree of freedom of 39; the χ^2 value of the two-factor model was 267.44 with 41 degrees of freedom. The χ^2 difference between these two models was 118.86 with 2 degrees of freedom, which was significant (the critical value: 5.99, degrees of freedom: 2, p value: 0.05). This suggests that the three-factor model was superior to the two-factor model. Following this, we found that the three-factor model performed best for both the Canada and US samples. In addition, the CFI and RMSEA of the three-factor model also showed a substantial improvement compared with the one-factor and two-factor models. The findings also show that the ICWc and ICWs were conceptually distinct.

Table 2. Tests of within-group measurement model fit [45].

Sample	Model	χ^2	df	χ^2 Difference	df Difference	χ^2/df	CFI	RMSEA
Canada (n = 771)	3-factor	148.58	39	-	-	3.81	0.97	0.06
	2-factor	267.44	41	118.86	2	6.52	0.94	0.09
	1-factor	1211.36	52	1062.78	13	23.3	0.71	0.18
US (n = 385)	3-factor	141.2	39	-	-	3.62	0.94	0.08
	2-factor	192.58	41	51.38	2	4.7	0.92	0.10
	1-factor	641.51	52	500.31	13	12.34	0.69	0.17

4.2. MI

Table 3 shows results from a series of increasingly restrictive tests of MI [45]. For each step, adequate measurement equivalence required that the absolute value of the CFI difference compared with the previous model should be less than 0.10 [42]. A configural invariance test of an equal number of factors and pattern of factor loadings indicated a good fit (χ^2/df = 3.72, CFI = 0.962, RMSEA = 0.070). Next, an additional constraint of equal factor loadings was imposed in the test of weak invariance. If this constraint did not substantially reduce model fit, then weak invariance could be supported. The results indicated that there was not a substantial reduction in model fit (CFI diff = −0.003), suggesting that the constraint may be retained since the strength of the relationship between the latent factors and the corresponding items were equivalent across the two groups. Then we tested whether the intercepts of the indicator variables were the same across the two groups, i.e., strong invariance. The results supported this equality constraint (CFI diff = −0.003). The last step was a strict invariance test, where the error variances were constrained to be equal across the two groups. The results also supported this equality constraint (CFI diff = −0.002). Therefore, the MI across Canada and US samples were supported, which suggests that Canadian and US respondents interpreted the three factors in a conceptually similar way.

Table 3. Test of MI across Canada and US samples [45].

Models	χ^2	df	χ^2/df	Compare	CFI diff	CFI	RMSEA
M1:configural invariance	289.783	78	3.72	-		0.962	0.070
M2: weak invariance	313.529	86	3.65	M1	−0.003	0.959	0.069
M3: strong invariance	340.688	94	3.62	M2	−0.003	0.956	0.069
M4: strict invariance	365.867	105	3.48	M3	−0.002	0.954	0.067

4.3. ICW Frequency Comparison

Table 4 shows the factor loadings and communalities of the indicator variables for each factor across the two samples. For example, the factor loadings of the five indicators of IR for the Canada sample ranged from 0.63 to 0.75, and for US sample, the IR factor loadings ranged from 0.55 to 0.76. Correspondingly, the communalities of the indicator variables (i.e., variance explained by the common factor) ranged from 0.40 to 0.56 for the Canada sample, and 0.30 to 0.58 for the US sample.

Table 4. Measurement model: factor loadings and communalities for Canada and US samples.

Factors	Indicator No.	Statements	Canada		US	
			Factor Loading	Communality	Factor Loading	Communality
Individual resilience	IR1	I remain calm when facing difficulties because I can rely on my coping abilities	0.75	0.56	0.73	0.53
	IR2	I am confident that I could deal efficiently with unexpected events	0.73	0.53	0.69	0.48
	IR3	I can cope with stress	0.68	0.46	0.55	0.30
	IR4	I can focus and think clearly when I am under pressure	0.67	0.45	0.70	0.49
	IR5	When confronted with a problem, I can usually find several solutions	0.63	0.40	0.76	0.58
Conflicts with supervisors	CS2	How often are your supervisors (subordinates) rude to you at work?	0.88	0.77	0.83	0.69
	CS3	How often do your supervisors (subordinates) do nasty things to you at work?	0.81	0.66	0.87	0.76
	CS1	How often do you get into arguments with your supervisors (subordinates)?	0.74	0.55	0.69	0.48
Conflicts with coworkers	CC2	How often are your coworkers rude to you at work?	0.83	0.69	0.80	0.64
	CC3	How often do your coworkers do nasty things to you at work?	0.83	0.69	0.83	0.69
	CC1	How often do you get into arguments with your coworkers?	0.68	0.46	0.60	0.36

The factor mean differences are shown in Table 5. In the estimation process, the factor means of the Canada group were fixed to 0, and the factor means were estimated in the US group [53]. As shown in Table 5, ICWs reported by the US respondents were significantly less than those reported by the Canadian respondents. No significant differences in IR and ICWc were found.

Table 5. Factors mean comparison between Canada and US samples [45].

Factors	Standardized Estimates
IR	0.04
ICWs	−0.17 *
ICWc	−0.06

Note: *: $p < 0.05$.

Table 6 shows the percentage of respondents who reported at least one ICW across the two countries. Overall, for each item of ICWs, US respondents reported less frequent occurrences, which is consistent with the results in Table 5. For ICWc, both the US and Canadian respondents reported a similar frequency for CC2 (i.e., "How often are your coworkers rude to you at work?") and CC3 (i.e., "How often do your coworkers do nasty things to you at work?"), while US respondents reported a lower frequency for CC1 (i.e., "How often do you get into arguments with your coworkers?").

Table 6. Frequency of each ICW items across Canada and US samples.

Country	Conflicts with Supervisors			Conflicts with Coworkers		
	CS1	CS2	CS3	CC1	CC2	CC3
Canada	51%	48%	37%	70%	70%	44%
US	42%	42%	25%	62%	70%	42%

CS1: How often do you get into arguments with your supervisors (subordinates)? CS2: How often are your supervisors (subordinates) rude to you at work? CS3: How often do your supervisors (subordinates) do nasty things to you at work? CC1: How often do you get into arguments with your coworkers? CC2: How often are your coworkers rude to you at work? CC3: How often do your coworkers do nasty things to you at work?

To explore why US respondents reported less conflict with their supervisors, Spearman's rank correlations between demographic information, collected in Table 1, and the three statements of ICWs were conducted (Table 7) [45]. The Spearman's rank correlation technique is a non-parametric test that has no data normality requirement. As shown in Table 7, age, the number of years with current employer, the number of projects in the previous 3 years, average weekly work hours, safety committee member percentage, and job position had significant relationships with one or two ICWs items. Further analysis was conducted to examine whether these six variables had significant differences between the US and Canada samples (Table 8) [45]. Another non-parametric test, Mann–Whitney, found that only age, the number of projects in the previous 3 years, safety committee member percentage, and supervisor percentage had significant differences across the two groups. The impact of project mobility on the occurrences of ICW on construction sites has been excluded [22]. Therefore, age, percentage of safety committee members, and supervisor percentage of the respondents might explain the difference in conflicts.

Table 7. Spearman's rank correlations between demographics and ICWs items across Canada and US samples [45].

Demographics	CS1		CS2		CS3	
	Canada	US	Canada	US	Canada	US
Age	-	-	-	−0.12 *	-	-
Years with current employers	0.07 *	0.16 **	-	-	-	-
No. of projects in the previous 3 years	-	-	-	-	-	−0.12 *
Average weekly work hours	0.12 **	-	0.07 *	-	-	-
Safety committee member percentage	-	0.15 **	-	-	-	-
Job position	−0.16 **	−0.21 **	-	-	-	-

Note: *: $p < 0.05$; **: $p < 0.01$.

Table 8. Demographics comparison between Canada and US respondents (Mann–Whiney test) [45].

Demographics	Canada	US	Differences
Age	36.8	38.5	1.7 **
Years with current employers	6.2	5.5	−0.7
No. of projects in the previous 3 years	10	17.2	7.2 ***
Average weekly work hours	44.3	45.2	0.9
Safety committee member percentage	37.5%	27.8%	−9.7% **
Supervisor %	29.2%	16.1%	−13.1% **

Note: **: $p < 0.01$; ***: $p < 0.001$

4.4. Prediction Relationship Comparisons

To test the impact of IR, ICWs, and ICWc on unsafe events, a set of structural models for both samples were tested. Figure 2 shows four models. The first model, S1, is a fully connected model. In addition to the four hypotheses to be tested, S1 includes two paths: IR -> unsafe events and ICWs -> unsafe events. Compared with S1, model S2 excludes the path from ICWs to unsafe events. The model fit statistics of S1 and S2 were compared (Table 9). The chi-square differences between S1 and S2 were 0.001 and 0.682 for the Canada and US sample, respectively, which were not significant for a 1 degree of freedom difference. Further, it was found that the parsimonious model, S2, was better than S1 for both samples based on the chi-square differences and the associated degrees of freedom differences.

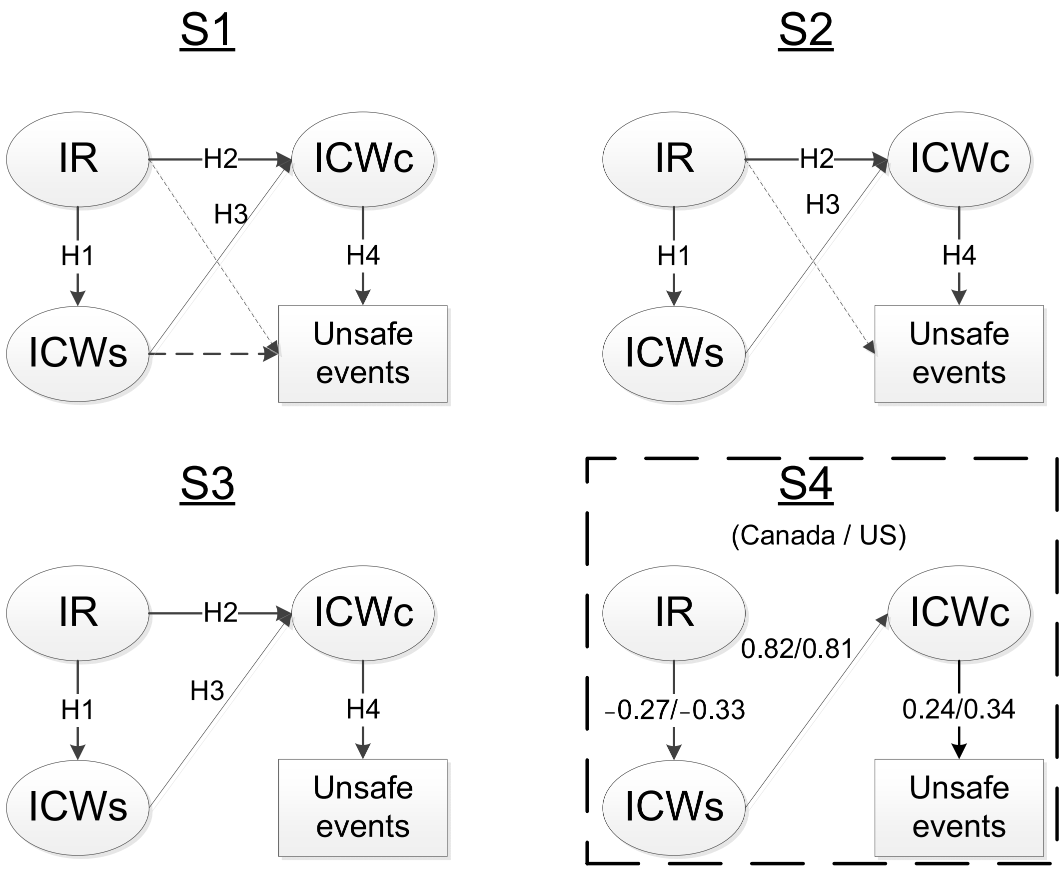

Figure 2. Models tested.

Table 9. Structural model test for Canada and US samples.

Sample	Model	χ^2	df	χ^2 Difference	df Difference	χ^2/df	CFI	RMSEA
Canada (n = 771)	S1	170.755	47	-	-	3.633	0.968	0.060
	S2	170.756	48	0.001	1	3.557	0.968	0.059
	S3	170.759	49	0.003	1	3.485	0.968	0.059
	S4	172.607	50	1.848	1	3.452	0.968	0.058
US (n = 385)	S1	160.671	47	-	-	3.419	0.940	0.080
	S2	161.353	48	0.682	1	3.362	0.940	0.079
	S3	161.913	49	0.56	1	3.304	0.940	0.078
	S4	165.502	50	3.589	1	3.310	0.939	0.078

Following this logic, S3 was compared with S2, and then S4 was compared with S3. S4 was found to be the best fit model for both samples. Therefore, H1, H3, and H4 were supported. In addition, a mediation test was conducted, which indicated that the impact of IR on ICWc was fully mediated by ICWs and the indirect effect was $\beta = -0.22$ and $\beta = -0.26$ for the Canada and US sample, respectively. Therefore, H2 was also supported.

The standardized regression coefficients are shown in S4. Differences in the regression coefficients across the two groups were found for two paths: IR -> ICWs, and ICWc -> unsafe events. Stronger relationships were found for the US sample, where the regression coefficients for the two paths were −0.33 and 0.34, while they were only −0.27 and 0.24 for the Canada sample.

5. Discussion

5.1. Overall Findings

This paper found that ICW on construction sites are positively related to construction safety performance for both Canada and US construction sites, i.e., ICW has the potential to cause more unsafe events. This paper is the first study that has validated this relationship across two countries in North America.

The MI tests demonstrated that all the four levels of MI were fully supported, which suggests that construction workers from the US and Canada sites interpret the IR and ICW in a conceptually similar way. This study firstly validated that ICW on US and Canada construction sites can be measured by ICWs and ICWc.

The results of the factor mean comparisons revealed that ICWs at the US construction sites were significantly less frequent that those at the Canada construction sites. Further analysis found that age, the percentage of safety committee members, and the supervisor percentage of the respondents might be the reasons. Some research has found that older adults have less interpersonal tension than younger people in their daily life [54]. The US respondents were significantly older than the Canada respondents, which might be one of the reasons. Safety is a very sensitive issue on construction sites. The safety committee members assist the employers to recognize workplace hazards, monitor and follow-up on hazard reports and recommend action, and participate in resolving workplace refusals and work stoppages, etc. [55]. Therefore, safety committee members may have more contact with workers and the nature of their work may cause more ICW. The fact that the US respondents had fewer safety committee members may lead to less ICWs. In the end, the US respondents had fewer supervisors, which may lead to less ICWs. More research is needed to validate the above findings.

The structural models across the two groups validated all four hypotheses. A "causal" chain "IR -> ICWs -> ICWc -> unsafe events" holds true for both US and Canadian construction workers. Differing from the Canada construction workers, the US construction workers reported a stronger negative relationship between IR and ICWs and a stronger positive relationship between ICWc and unsafe events. The reasons behind this need to be explored.

5.2. Significance of the Study and Theretical Contributions

This study holds paramount significance in the field of construction safety, as it marks the first attempt to systematically investigate and validate the positive relationship between ICW and construction safety performance across both Canadian and US construction sites. The inclusion of two distinct countries not only broadens the generalizability of the findings but also contributes to a more comprehensive understanding of the impact of interpersonal conflicts on construction safety. By identifying and validating key variables such as interpersonal conflicts with supervisors and coworkers as measures of conflict, this study provides a solid foundation for future research and intervention efforts.

The theoretical contribution of this study lies in its exploration of the conceptual similarities in the interpretation of IR and ICW among construction workers in both the United States and Canada. By establishing a common understanding of these psychological and interpersonal factors, this study enriches existing theories on workplace dynamics and safety within the construction industry. Furthermore, the validation of specific measures for interpersonal conflicts contributes to the refinement of theoretical frameworks related to conflict assessment in construction settings.

5.3. Practical Implications

From a practical perspective, the findings of this study have direct implications for industry practitioners, policymakers, and safety professionals. The recognition that ICW significantly influence construction safety performance underscores the need for targeted interventions and management strategies. Understanding the shared interpretations of IR and conflicts by workers from different countries enables the development of cross-cultural training programs, fostering a safer and more harmonious work environment.

Moreover, this study's identification of IR as a factor influencing the occurrence of ICW opens avenues for proactive safety measures. Interventions aimed at enhancing IR may not only reduce the likelihood of conflicts but also contribute to mitigating unsafe events among construction workers. This practical insight can guide the development of tailored training programs and policies to address both interpersonal conflicts and IR within the construction industry.

5.4. How to Improve IR and Reduce ICW of Construction Workers?

Work shifts, long work hours, role ambiguity, and job demand are risk factors for ICW, while social support from supervisors and or coworkers significantly protect against the onset of both coworker and supervisor conflict [56]. For construction sites, especially the sites with day and night shifts, it is important to avoid frequently rotating shifts which may cause sleep disorders and lead to more ICW. In addition, a good schedule is important for job demand management. Finally, coarse language and banter are very common on construction sites. However, people are different in terms of their ability to understand and cope with the stress this might cause. Therefore, it is important to establish a clear boundary that distinguishes banter from harassment. In addition, the masculine norms in the construction industry affect construction workers' perceptions toward occupational safety and health [57] and are related to the job stress or mental health of construction workers [58]. Although it might be hard, obtaining support from the top management of construction companies across the whole industry to change the culture and thus provide a more friendly work environment for the construction workers might help reduce ICW on construction sites and build trust among workers.

Individual coaching can enhance self-confidence and personal insight and help build management skills [59]. For construction sites, especially large sites with hundreds of construction workers, it may not be feasible to coach every construction worker. However, management may start by training supervisors and/or foremen who directly and daily communicate with workers. Once site supervisors are aware of the issues related to conflict and harassment, they can practice what they have learned and share their knowledge with workers, perhaps during safety talks.

5.5. Limitations and Future Work

Despite the valuable contributions, it is essential to acknowledge certain limitations inherent in this study. The cross-sectional nature of the research design limits our ability to establish causality definitively. Future longitudinal studies could provide a more nuanced understanding of the temporal dynamics between interpersonal conflicts, IR, and construction safety performance.

Additionally, this study focused specifically on the construction industry in the United States and Canada. While this enhances the generalizability within North America, caution should be exercised in extrapolating these findings to construction contexts in other regions with potentially distinct cultural, organizational, and regulatory dynamics.

Furthermore, the reliance on self-reported data introduces the possibility of response bias and may not fully capture the complexity of interpersonal conflicts and IR. Future research could benefit from mixed-method approaches, incorporating qualitative assessments and observational data to provide a more comprehensive understanding of these phenomena.

This paper only focused on one personal resource (i.e., IR), one hindrance factor (i.e., ICW), and the physical safety performance (i.e., unsafe events). In the future, more research can be conducted to investigate what other personal resources, workplace resources (e.g., mentorship program, employee assistant program), hindrance stressors (e.g., workplace politics), and challenge stressors (e.g., work pressure) can significantly affect construction workers' safety as well as health (e.g., physical injuries and job stress). Figure 3 shows a conceptual framework for future work within the JDCS model framework. In addition, it may be worth investigating the differences of the model in Figure 3 when focusing on different construction sectors (e.g., residential vs. heavy civil), communities (e.g., people live in different communities may present different patterns in terms of culture and perceptions), and even countries (e.g., different culture and language may affect people's perceptions).

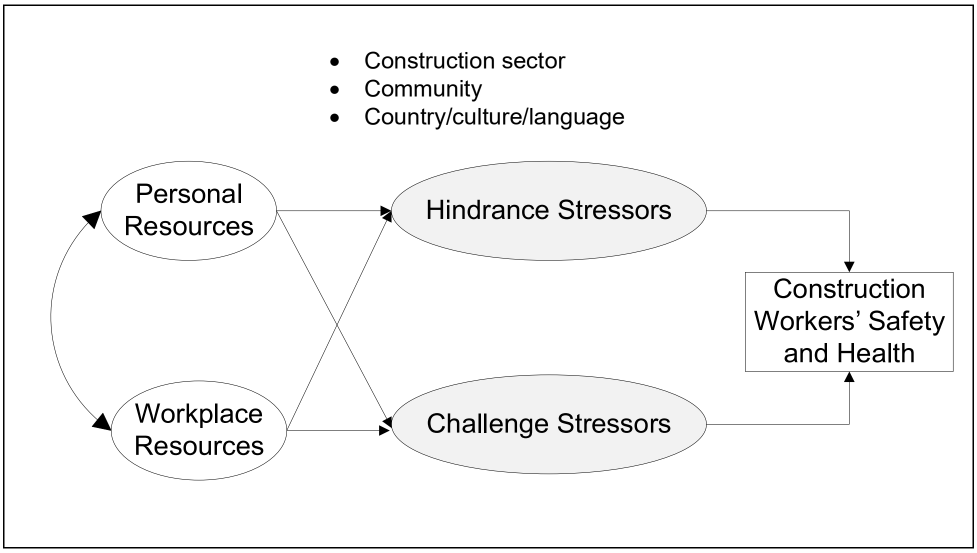

Figure 3. A Conceptual Framework for Future Research.

6. Conclusions

This study compared the frequency of ICW on US and Canada construction sites and confirmed the mitigation impact of IR on ICW and the impact of ICW on unsafe events. It is the first study showing that construction workers from the US and Canada interpret the studied questions in a similar way, which implies that the three scales can be universally applied in North America.

The structural models validated four hypotheses across Canada and US:

H1. *IR is negatively associated with ICWs across Canada and US.*

H2. *IR is negatively associated with ICWc across Canada and US.*

H3. *ICWs has a positive relationship with ICWc across Canada and US.*

H4. *ICWc has a negative relationship with unsafe events on construction sites across Canada and US.*

The "causal" chain "IR -> ICWs -> ICWc -> unsafe events" holds true for both Canada and US construction workers. Differing from the Canadian construction workers, US construction workers reported a stronger negative relationship between IR and ICWs and a stronger positive relationship between ICWc and unsafe events.

In addition, US respondents reported fewer conflicts with their supervisors, which may be related to their slightly older age, their lower participation in safety committees, or fewer supervisors on site.

This study makes a theoretical contribution by examining the conceptual similarities in how construction workers in the United States and Canada interpret IR and ICW. The exploration of shared understandings regarding psychological and interpersonal factors enhances existing theories on workplace dynamics and safety within the construction industry. From a practical standpoint, this study's findings carry direct implications for industry practitioners, policymakers, and safety professionals. The acknowledgment that interpersonal conflicts significantly impact construction safety performance underscores the importance of targeted interventions and effective management strategies.

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