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GLOBAL DIFFERENCES IN RISK TOLERANCE LEVELS AMONG CONSTRUCTION WORKERS

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Abstract: A critical component of maintaining safety is to ensure that workers feel uncomfortable partaking in risky behavior. An individual's willingness to engage in unsafe behavior is measured as risk tolerance. Given its subjective nature, risk tolerance is challenging to manage. However, understanding and influencing risk tolerance is essential to promoting safe behavior and increasing adherence to policies and procedures. This paper empirically examines the differences in risk tolerance levels among construction workers with data from a survey administered with 12,323 workers from 19 countries. One-way ANOVA shows that workers from countries examined in the survey registered statistically significant differences in personal and work-related risk tolerance levels. Furthermore, there seems to be positive association between personal and work-related risk tolerance. These findings suggest that an individual's personal risk tolerance may have a strong bearing on their willingness to engage with risk at work and personal and work-related risk tolerance levels may be very different across geography and culture. If an organization seeks to align or manage risk tolerance to an acceptable level, it should endeavor to understand personal and cultural factors that influence risk-taking behavior. Future research should investigate whether specific personality characteristics, social interactions, and organizational safety practices influence risk tolerance and shape workplace behavior.

1. INTRODUCTION

The high fatality and injury rates continue to plague the global construction industry (BLS 2017). One possible explanation is that standard safety training programs are failing to increase risk aversion among workers. As globalization continues, it is important to understand how risk tolerance varies across geographical regions. There have been fair number of studies exploring risk-taking behaviors on a global scale (Hofstede 1983; Kreiser et al. 2010; Mihet 2013), but none are specific to the construction industry. Surprisingly, even countries with more advanced safety regulatory bodies are not necessarily delivering better safety performance than countries with less developed regulation system (Mearns and Yule 2009). This indicates that the determinants of risk tolerance might not be tied to just rules and processes and may have underlying socio-cultural explanations.

Risk tolerance is defined as the level of risk that an individual is willing to accept to attain some desirable goal. The tension between perceived risk and reward helps to characterize risk tolerance. The extent to which individuals are willing to engage in risky behavior is determined by a number of factors ranging from psychological, such as emotions (Slovic et al. 2007), personality (Filbeck et al. 2005; Zuckerman 1979),

and biases (Odean 1998; Roszkowski and Snelbecker 1990), to social, such as work experience (Hallowell 2010) and culture (Burke et al. 2008; Irwin 1993). Given that risk tolerance is influenced by social and psychological factors that vary on individual and community levels, it is likely that organizations pursuing *one size fits all* policies towards safety would be ineffective in calibrating safety behavior (Törner et al. 2009).

Differences in perception and evaluation of risk across cultures has been extensively studied. For example, Camprieu et al. (2007) and Zwikael and Ahn (2011) found that there were significant differences in in perceptions and evaluations of risk Canadian-Chinese and Japanese-Israeli pairwise comparisons. These differences were thought to exist because safety culture is influenced by national culture and the extent to which risk and uncertainty is generally avoided or accepted (Hofstede et al. 2001).

Hofstede (1983) suggested that a national culture is typically comprised of 5 unique dimensions: *power distance*, *uncertainty avoidance*, *individualism*, *masculinity index* and *long-term orientation*. The dimension most relevant to risk, *uncertainty avoidance*, indicates the degree to which a society depends on norms, rules, and procedures to alleviate ambiguity and uncertainty of future events. Thus, a society with a high uncertainty avoidance score often characterize an *unknown* as highly threatening and people within that community generally tend to avoid risky situations (Hofstede 1983). Despite established cultural differences, most multinational construction companies aim to establish a standardized approach to safety (e.g., policies, management strategies, and prevention programs). However, it is unlikely that a standardized safety management approach will alter disparate locally-held cultural values (Hassi and Storti 2011) that relate to risk-taking behavior to show ubiquitous change in willingness to engage in risky behavior among construction workers across the globe. Although researchers have examined risk tolerance from the purview of a particular country or region (Hallowell 2010; Ken and Alan 2018; Lu and Yan 2013), differences in risk tolerance across countries has not been compared on a global scale. With increased trends toward globalization (Han et al. 2010), it is critical to understand if, and to what extent, there are differences in the risk-taking behaviors across geographical regions.

In addition to geographical differences, there may be individual differences in risk tolerance. Recent studies suggest that willingness to engage in risk-taking behavior in personal life may predict work-related risk tolerance (Wong and Carducci 1991), especially for individuals working in high stress environments (Holcom et al. 1993). There is some evidence that shows personal and job factors increase the likelihood among workers to engage in substance and alcohol abuse (Gleason et al. 1991; Lehman and Bennett 2009). However, it remains unclear if willingness to engage in risky behavior in personal life can increase the tendency to accept risk in the work environment among construction workers.

Thus, the purpose of this study is to:

1. Conduct exploratory research on whether personal and work-related risk tolerance of construction workers belonging to same company can vary across countries.

2. Conduct exploratory research on which country versus country risk tolerance differences were statistically significant.

3. Validate if personal risk tolerance of workers can influence work-related risk tolerance.

2. RESEARCH METHODS

A total of 12,323 construction workers from 19 countries were surveyed for this study. Participants worked in the same the building construction trade and were employed (or contracted) by the same company which provided uniformity in work scope. This consistency makes it appropriate for us to compare risk tolerance levels across countries. The questionnaire used (shown in Figure 1) required participants to note the degree to which agreed with each prompt on a scale of 1-4 where: 1 represents strongly disagree; 2 represents disagree; 3 represents agree; and 4 represents strongly agree. Work-related risk tolerance was measured by the items 1-7 and personal risk tolerance was measured by the items 8-13.

Workers were informed that their participation was anonymous, voluntary, and uncompensated. They were also given the autonomy to withdraw from the study at any time. All subjects took the surveys online to avoid any undue biasing effects from peers or employers. Workers had the choice to take the survey in their native languages or English. The sheer volume of data collected lends the analysis presented in the following section with high external and ecological validity. While some studies in construction domain do sample participants from target population, however datasets leveraged there are fairly homogenous in nature. By capturing key demographics in this dataset, we are able to establish *generalizability* and *reliability* to high degree. However, we recommend future studies to validate the findings of this study by enhancing the internal validity.

		STRONGLY DISAGREE	DISAGREE	AGREE	STRONGLY AGREE
		1	2	3	4
1.	Sometimes risks need to be taken to get the job done.	o	o	o	o
2.	I like doing two things at once (multi-tasking).	o	o	o	o
3.	I actually enjoy following rules and procedure.	o	o	o	o
4.	Some people can drive cars or operate machinery safely with not enough sleep.	o	o	o	o
5.	Some people can skip unnecessary steps safely to get a job done quickly.	o	o	o	o
6.	Others can easily distract me when I am working on a difficult task.	o	o	o	o
7.	This is a tough industry that requires tough workers.	o	o	o	o
8.	I consider my choices carefully before making a risky decision.	o	o	o	o
9.	I am comfortable walking home alone at night in an unsafe part of the town.	o	o	o	o
10.	I enjoy doing things that were not planned.	o	o	o	o
11.	I get annoyed or angry with others easily if they do not agree with my opinions.	o	o	o	o
12.	I enjoy doing or watching dangerous activities like tightrope walking, swimming with sharks, skydiving etc.	o	o	o	o
13.	I would not be afraid to walk in the wilderness among wild animals.	o	o	o	o

* Scoring Procedure:
- Reverse code items 3 and 8.
- Items 7 and 8 were dropped to increase the reliability of work-related and personal risk tolerance scales respectively (see results section).
- For work-related risk tolerance subscale: sum items 1, 2, 3, 4, 5, and 6.
- For personal risk tolerance subscale: sum items 9, 10, 11, 12, and 13.

Figure 1: Risk Tolerance Survey Instrument

3. RESULTS

Participants with missing data were dropped from the analysis because they represented an inconsequential percentage (4.16%) of the entire dataset. We used Cronbach's alpha to gauge the internal consistency for work-related and personal risk tolerance scales. The internal consistency of work-related risk tolerance scale was improved from 0.64 to 0.70 by dropping the question *This is a tough industry that requires tough workers*." Similarly, the question "*I consider my choices carefully before making a risky decision*" was dropped to improve the internal consistency of personal risk tolerance scale from 0.53 to 0.60. Given the high variability associated with sampling individuals from different countries, achieving a moderately high reliability across the scales within the questionnaire is significant (Helmstadter 1964; Nunnally and Bernstein 1967). Figure 2 summarizes the research questions and the analysis approach adopted by authors.

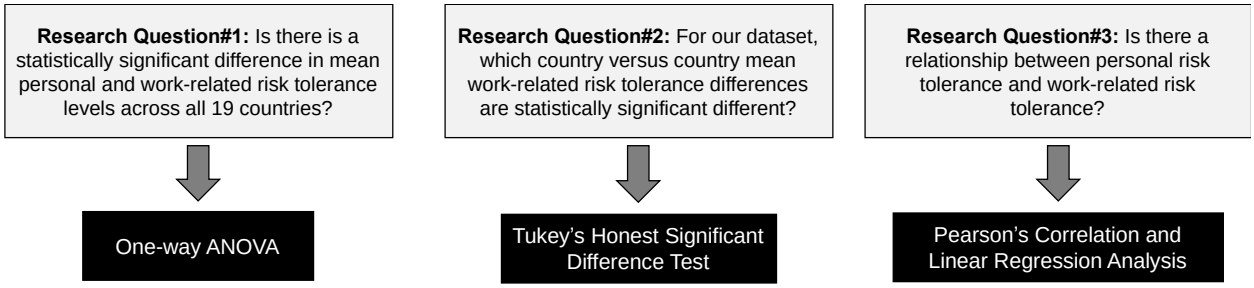

Figure 2: Analysis Approach

The total work-related and personal risk tolerance scores for each participant was calculated by taking the sum of the individual items on each scale, where the total personal and work-related risk tolerance score could range between 6-24 and 5-20, respectively. A high score indicated a higher risk tolerance and vice versa. Also, to account for positive skew, both risk tolerance scores were log-transformed. Table 1 shows the mean (scaled and centered) of work-related and personal risk tolerance by country for this dataset. For work-related risk tolerance, Australia (mean =0.63) and East Asian countries (mean = 0.10) reported higher levels of risk tolerance. Central American (mean = -0.16), South American (mean = -0.29), South Asian (mean = -0.30), and European (Spain and Turkey; mean = -0.50) countries reported comparatively lower risk tolerance levels. This is an interesting finding because it shows that workers belonging to same organization (i.e., similar safety culture, incentive, and skill-development programs) have vastly different risk tolerance. Similarly, for personal risk-tolerance, workers from Australia (mean = 0.75), Europe (mean = 0.22), and East Asia (mean = 0.03) showed more willingness to partake in risk-taking behavior in their personal life, whereas workers from South America (mean = -0.25), Central America (mean = -0.31), and South Asia (mean = -0.35) reported they were less willing to engage risky behavior in daily life.

Table 1: Mean Risk Tolerance by Country

Work-related Risk Tolerance				*Personal Risk Tolerance*			
COUNTRY	SAMPLE SIZE	MEAN	STD. DEV.	**COUNTRY**	SAMPLE SIZE	MEAN	STD. DEV.
Japan	1160	0.76	0.80	**Australia**	87	0.75	0.81
Australia	87	0.63	0.76	**Japan**	1160	0.49	0.81
Singapore	57	0.61	1.12	**Singapore**	57	0.43	1.17
Hong Kong	783	0.50	0.85	**Spain**	678	0.33	1.04
Malaysia	222	0.36	0.98	**Hong Kong**	783	0.21	0.88
Indonesia	115	0.20	0.82	**Vietnam**	54	0.02	0.85
Vietnam	54	0.12	0.82	**Malaysia**	222	-0.02	0.98
Thailand	230	0.00	0.89	**China**	5714	-0.04	0.97
China	5714	-0.07	0.96	**Turkey**	279	-0.04	1.07
Korea	649	-0.11	0.90	**Colombia**	94	-0.08	1.02
Turkey	279	-0.14	1.00	**Indonesia**	115	-0.12	0.88
Mexico	85	-0.16	0.98	**Thailand**	230	-0.15	0.98
Uruguay	38	-0.21	0.85	**Uruguay**	279	-0.2	0.9
Brazil	711	-0.27	0.92	**Brazil**	711	-0.23	1.01
India	748	-0.3	1.08	**Korea**	649	-0.31	0.93
Colombia	94	-0.33	0.96	**Mexico**	85	-0.31	1.1
Chile	73	-0.37	1.00	**India**	748	-0.35	1.14
Argentina	33	-0.64	1.11	**Chile**	73	-0.49	1.09
Spain	678	-0.64	0.93	**Argentina**	33	-0.72	1.24

To test if the differences in work-related risk tolerance means by country shown in Table 1 are statistically significant, we used one-way ANOVA test. One-way ANOVA is commonly used to compare means against a dependent variable in this case, *country*. Results show that the observed differences in work-related risk

tolerance means of the countries are indeed statistically significant differences (F [18, 11791] = 91.3; p < 2e-16).

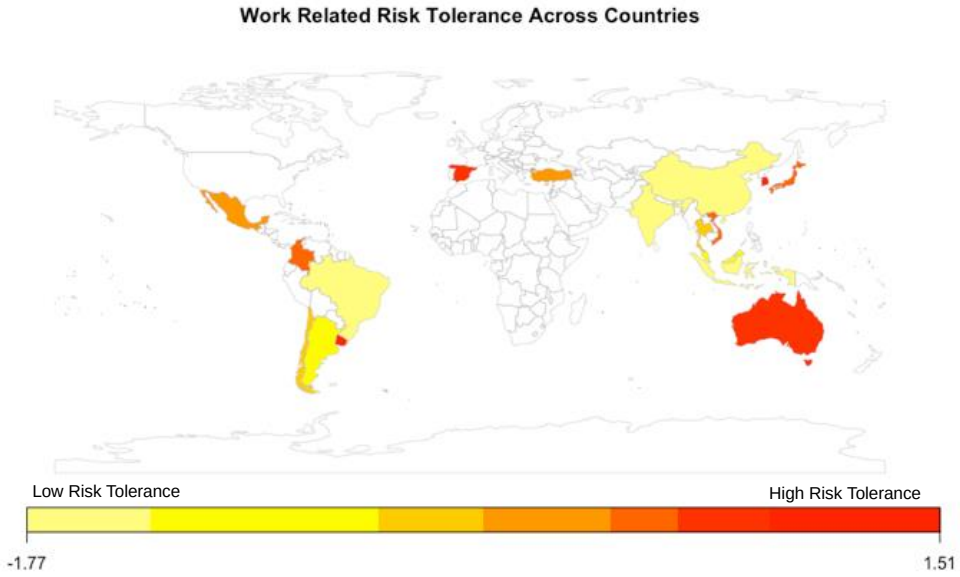

Figure 3: Work-related Risk Tolerance Heat Map

Similarly, we examined if there is a statistically significant difference in personal risk tolerance levels among construction workers across 19 countries. Results show that mean personal risk tolerance of the countries is significantly different (F [18, 11791] = 41.4; p < 2e-16). Figure 3 and Figure 4 show heat-maps of work-related and personal risk tolerance means across countries, respectively. The implication of this high variability in personal and work-related risk tolerance is that standardized safety management strategies may not yield consistent aversion to risk-taking habits. Consequently, multinational construction organizations should consider avoiding *one size fits all* policies and tailoring safety management approaches to each major geographical region.

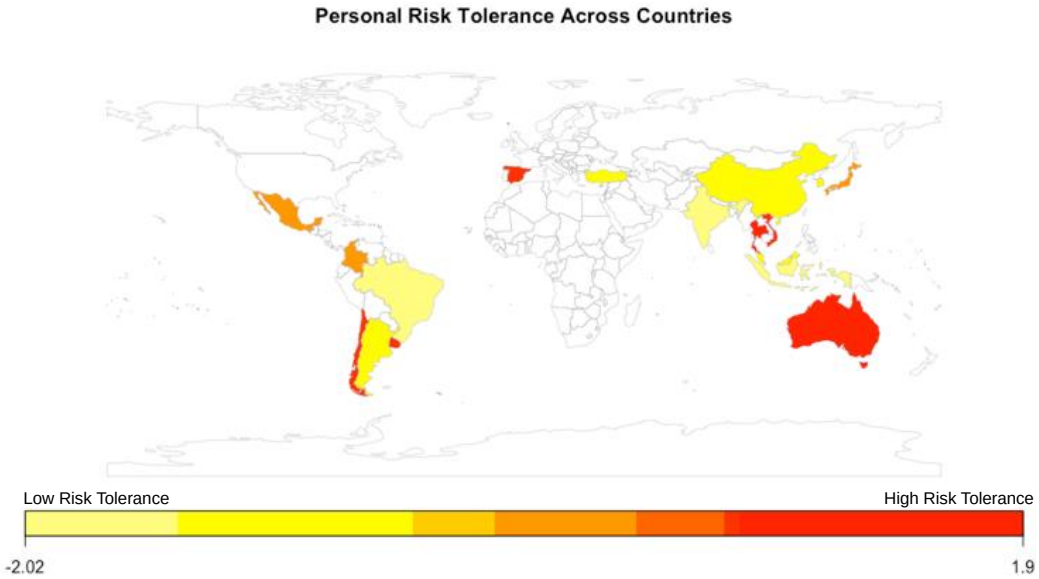

Figure 4: Personal Risk Tolerance Heat Map

While one-way ANOVA reveals if the overall difference in means of risk tolerance is significant, it does not reveal where specific differences exist. In other words, ANOVA cannot be used to make pairwise comparisons that reveal which differences exist across countries. Tukey's Honest Significant Difference Test (HSD) is a post-hoc test usually performed after an ANOVA test reveals a statistically significant relationship that runs multiple pairwise comparisons and locates where the specific differences are (Williams 1974). This test compares all possible pairs of means but unlike t-tests, it accounts for multiple tests and adjusts the p-value accordingly thereby protecting against Type 1 error (Williams 1974). Table 2 shows only the statistically significant pairwise differences in work-related risk tolerance means between countries. Clearly, there are significant differences in work-related risk tolerance levels across many countries regardless of geographical proximity or distance. For brevity, pairwise differences in personal risk tolerance means by countries cannot be presented here.

Table 2: Pairwise Comparisons of Risk Tolerance Means by Country (*all statistically significant $p < 0.03$)

Pairwise Country Comparison	Difference in Means	Pairwise Country Comparison	Difference in Means
Thailand-Argentina	0.64	Japan-Argentina	1.40
Vietnam-Argentina	0.76	Brazil-Australia	-0.90
Thailand-Brazil	0.27	Chile-Australia	-1.00
Korea-India	0.20	China-Australia	-0.70
Indonesia-Chile	0.57	Colombia-Australia	-0.96
Indonesia-Colombia	0.53	India-Australia	-0.93
Thailand-Malaysia	-0.36	Korea-Australia	-0.73
Uruguay-Singapore	-0.82	Spain-Australia	-1.27
Thailand-India	0.30	Turkey-Australia	-0.77
Mexico-Malaysia	-0.52	Hong Kong-Brazil	0.94
Thailand-Singapore	-0.61	Japan-Brazil	1.03
Indonesia-Argentina	0.84	Malaysia-Brazil	0.63
Spain-Mexico	-0.49	Singapore-Brazil	0.88
Uruguay-Hong Kong	-0.16	Spain-Brazil	-0.37
Uruguay-Australia	-0.84	Hong Kong-Chile	1.28
Singapore-Mexico	0.77	Japan-Chile	1.13
Vietnam-Japan	-0.64	Hong Kong-China	0.70
Indonesia-Brazil	0.47	Japan-China	0.84
China-Brazil	0.20	Malaysia-China	0.43
Indonesia-India	0.50	Spain-China	-0.57
Thailand-Australia	-0.63	Hong Kong-Colombia	1.19
Singapore-China	0.68	Japan-Colombia	1.09
Mexico-Australia	-0.78	India-Hong Kong	-0.64
Turkey-Singapore	-0.75	Korea-Hong Kong	-0.43
Singapore-Korea	0.72	Spain-Hong Kong	-0.97
Malaysia-Argentina	1.00	Thailand-Hong Kong	-0.26
Vietnam-Spain	0.76	Turkey-Hong Kong	-0.41
Malaysia-Chile	0.73	Japan-India	1.06
Malaysia-Japan	-0.40	Malaysia-India	0.66
Singapore-Chile	0.98	Singapore-India	0.91
Turkey-Malaysia	-0.50	Spain-India	-0.34
Malaysia-Colombia	0.69	Spain-Indonesia	-0.84

Singapore-Colombia	0.94	Korea-Japan	-0.87
Japan-Hong Kong	0.41	Mexico-Japan	-0.92
Singapore-Argentina	1.25	Spain-Japan	-1.41
India-China	-0.23	Thailand-Japan	-0.77
Mexico-Hong Kong	-0.28	Turkey-Japan	-0.90
Japan-Indonesia	0.57	Malaysia-Korea	0.47
Uruguay-Japan	-0.97	Spain-Korea	-0.54
Australia-Argentina	1.27	Spain-Malaysia	-1.00
Hong Kong-Argentina	1.14	Spain-Singapore	-1.25
Thailand-Spain	0.64	Turkey-Spain	0.50

Finally, we were interested in examining if there is a relationship between personal and work-related risk tolerance. To this end, we used Pearson correlation which is an indicator of linear relationship between two variables. The correlation coefficient for the relationship between work-related risk tolerance and personal risk tolerance was high (0.59) and statistically significant ($p < 0.01$). Further, linear regression analysis also shows that personal risk tolerance is positively associated with work-related risk tolerance where every unit increase in personal risk tolerance increases risk tolerance by 0.59 units. This relationship is highly significant ($F(1, 11808) = 6214$, $p < 2e\text{-}16$) even after applying the Benjamini–Hochberg procedure to control for false discovery rate (Benjamini and Hochberg 1995).

The results presented in this paper highlight two findings:

1. Risk tolerance levels among construction workers within an organization in the same trade varies significantly across geographical regions.
2. Willingness to accept risk in work-environment among construction workers is associated with willingness to participate in risky behavior in everyday life.

4. DISCUSSION AND FUTURE WORK

While much effort has been made to reduce fatality and injury rates on construction sites through technical solutions and by implementing rigorous rules and regulations, not enough attention has been given to the individual specific attitudes and perceptions. Moreover, differences and trends in risk tolerance across countries remains nebulous but important as globalization increases. The results from the present study indicate that for a multinational organization working in the same trade, there are statistically significant differences in both personal and work-related risk tolerance.

Pidgeon (1991) characterized safety culture as the collection of accepted beliefs, norms, attitudes, and roles within a social or technical environment that focus on controlling dangerous activities that could cause harm to an individual. Despite controlling for risk exposure, the observed difference in risk tolerance levels observed implies that standardized safety management practices may not yield equally risk-averse workforces across the globe. This suggest that multinational organizations, cannot consider safety only from an organizational standpoint and should account for individual factors and cultural differences. Furthermore, despite *certain* cultural similarities among countries within a continent, our findings show that there are statistically significant differences in risk tolerance among countries that are geographically close (Table 2). Therefore, it is necessary to manage safety *on crew level* by improving safety knowledge (Larsson et al. 2008), attitudes and motivation (Parker et al. 2003), communication (Rochlin 1999), and supervision (Zohar 2002).

Another interesting finding is the observed relationship between personal and work-related risk tolerance, which has not been discussed, up to now, from a construction safety perspective. The finding suggests that an increase in willingness to accept risk in everyday life is also associated with an increase in willingness to accept risk at work. In other words, it behooves industries that need to train its employees on safety to shift focus from simply delivering *occupational safety training* to providing a more *holistic risk avoidance training*. Although training can be provided on any number of risks that an individual has to routinely

rationalize (e.g., financial, health and well-being, and sensation-seeking), it is unclear if training provided on any of these risks would be equally effective in improving overall risk-averse behavior. In other words, does health and well-being safety training increase risk-averse behavior in work-environment more than financial safety training? The data collected did not allow us to make any conclusive analysis on this matte, which could be addressed in a future study.

We recommend future studies to manage the translational process of the survey to ensure high comprehension and relevancy of questions (Van de Vijver and Leung 1997). Furthermore, a question like, ""*I enjoy doing or watching dangerous activities (like tightrope walking, swimming with sharks, sky-diving, etc.)*" in the survey might not be relevant for workers across the globe. Thus, while the propensity to engage in risky behavior in work-environment aligned fairly well with Hofstede's uncertainty avoidance score for each country, the same could not be concluded for workers' tendency to engage in risky behavior in their personal lives (Hofstede Insights 2019).

In conclusion, the increasing globalization of the construction industry requires researchers to conduct safety culture and climate assessments at an international level. This study may be used to catalyze discourse on global differences in appraisal and comfort with safety risks. Organizations may consider localized factors (*such as* culture, demographic makeup, and educational background) when designing safety programs and intervention strategies to condition behavior effectively. Furthermore, investing in risk avoidance training in workers' personal lives may yield reduced willingness to accept risk in work environment.

Although this study lacks internal validity because of low experimental control, psychological and social theories are rarely validated on the target population and on a large scale, especially in construction engineering and management research. From an academic standpoint, the relationship between personal and work-related risk tolerance in an occupational safety context has not been discussed before and opens interesting avenues for future research. Future researchers may address the limitations of this study and examine how, if at all, demographic dimensions and specific organizational safety practices mediate the relationship between personal and work-related risk tolerance. Such explorations will further establish our understanding on the prerequisites for effective design and delivery of safety training for construction workers.

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