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Original Research Article

Impact of Safety Climate and OHSMS for Effective Safety Performance in Hydropower Construction Project: Mediation-Moderation Model

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Abstract

The core objective of this research is to investigate the association between Safety Leadership (SL), Safety Climate (SCL), Occupational Health and Safety Management System (OHSMS), and Safety Performance (SP). The research is grounded in 307 usable survey responses gathered from a hydropower construction firm, employing a cross-sectional design. The researcher used SPSS 23 and Amos 21 for structural equation modelling. Study results indicated that SCL serves as a positive complementary partial mediator between SL and SP. Additionally, the study presents a novel investigation into the moderating effect of OHSMS, demonstrating its supportive role in aligning SL with SCL to enhance sustainable SP outcomes. This research provides additional empirical support for the direct links between SL and SP, and between SL and SCL. Moreover, the study emphasizes the moderating effect of OHSMS within the mediated relationship of SL between SCL and SP. Additionally, this empirical evidence can serve as a valuable guide for managers and safety practitioners in developing countries to enhance the sustainable SP of hydropower construction firms.

Keywords: Moderation Mediation Model, OHSMS, Safety Climate, Safety Leadership, Safety Performance.

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INTRODUCTION

Construction firms are complex-nature industries due to tough work situations and high-risk tangles Yiu *et al.,* (2019) , which account for about 1 in every 5 occupational mortalities(Asadzadeh *et al.,* 2020). Construction injuries are often the product of interaction among the workplace, apparatus, and material, and work crew, accounting for 70% of injuries and mortalities (Mroszczyk, 2015). A prior study also identified that accidents in construction firms happen due to several measures, such as insufficiencies in management, unsafe workplaces, worker actions, etc.(Enya *et al.,* 2018). Moreover, the complexity and variability of construction project sites make the implementation of safety management and the achievement of safety performance more challenging compared to other types of firms (Guo *et al.,* 2017). Construction firms play a crucial role in the social and economic development of developing countries; however, safety practices often receive limited attention. In Nepal, many contractors tend to overlook established safety regulations. To minimise costs, they reduce safety measures, which ultimately results in greater long-term losses due to workplace accidents. For example, project managers, supervisors, and workers frequently lack adequate knowledge of OHSMS, contributing to higher accident rates on construction sites.

OHSMS is a complex problem that includes multiple layers and offshoots around it; just one-stop solution cannot be found. In Nepal, this challenge is further intensified by the lack of effective government policies, legislation, managerial commitment, supportive workplace environments, and workers' willingness to adopt safe practices.

The construction firm plays a crucial role in the efficient and effective delivery of infrastructure, which is essential for the Nepalese government to manage properly. In recent years, OHSMS has become a prominent focus in both research and practice, driven by the high rates of accidents and fatalities in construction firms (Gautam & Prasain, 2011). Effective OHSMS are crucial to ongoing projects to improve safety

performance, with the groundwork of safety leadership in any construction project (Jazayeri & Dadi, 2017).

There is limited comprehensive evidence to verify the effectiveness of OHSMS in improving safety performance within construction firms (Robson *et al.,* 2007). To address this research gap, the study aims to examine the empirical indirect relationship of safety climate between safety leadership and safety performance, while also exploring the moderating role of OHSMS in the relationship between safety leadership and safety climate, to ensure effective and sustainable safety performance in construction firms in developing countries such as Nepal.

LITERATURE AND HYPOTHESES

SL is defined as the process by which a leader exerts influence over employees' daily work activities through effective communication to achieve a reduced accident rate and enhanced safety performance (Kerin, 2020).SL can efficiently contribute to construction firm safety. Effective SL is essential for any organization, as it inspires employees to adopt safe behaviors, serves as a role model, and demonstrates a strong commitment to safety. To support this, an SL program has been developed to provide frontline personnel across businesses of all sizes with essential knowledge and skills in safety leadership. For any construction project to be a success, proper handling of workers' safety issues is a prime need, which can only be possible in the presence of good SL (Rahman & Al-Emad, 2018).

- W1: SL has a positive correlation with SP
- W2: SL has a positive correlation with SCL

SC indicates the feeling shared by workers of the primacy of safety as linked to other targets sought by the firm, such as efficiency, productivity, etc (Zohar, 2010). Cultivating a satisfactory safety climate is critical to the progress of safety performance in any firm (Wu *et al.,* 2015). Prior research also identified that in the presence of a better safety climate, there will be a negligible chance of violation of safety measures in a construction firm (Lee *et al.,* 2020).

- W3: SCL has a positive correlation with SP
- W4: SCL serves as a mediator in the relationship between SL and SP

OHSMS is a grouping of scheduling and evaluation, management and organizational management, the consultative arrangement, and the specific program element, which are implemented together to advance health and safety performance (Gallagher, 2001). Prior research proposed OHSMS as an integral part of the overall management framework that supports the control of occupational safety and health risks associated with a company's operations (Kamar *et al.,* 2014). The occupational safety and health (OSH) management system is acknowledged as a key tool for improving poor OSH performance (Qiang & Ki Chow, 2007). The importance of OHSMS at construction firms is recognized by the management level along with the workers, but it seems that in construction firms in developing countries, construction uses it effectively (Simukonda *et al.,* 2020).

- W5: OHSMS moderates the mediating effect of SCL on the relationship between SL and SP such that the effect of SL on SP is stronger when OHSMS is high than when it is low.

SP can be described as the rate of accidents and work-related injuries reported by individuals themselves (Siu *et al.,* 2004). Earlier studies measure safety performance to detect initial threatening signs and act quickly if emergency action is essential. Moreover, measuring SP acts as a navigation tool that can alter future safety behavior in the workplace for workers (Jazayeri & Dadi, 2017). Senior managers are responsible for establishing organizational systems, including the design and implementation of the safety management system. Effective safety performance must start with management's own commitment to improving overall workplace conditions (Kapp *et al.,* 2003).

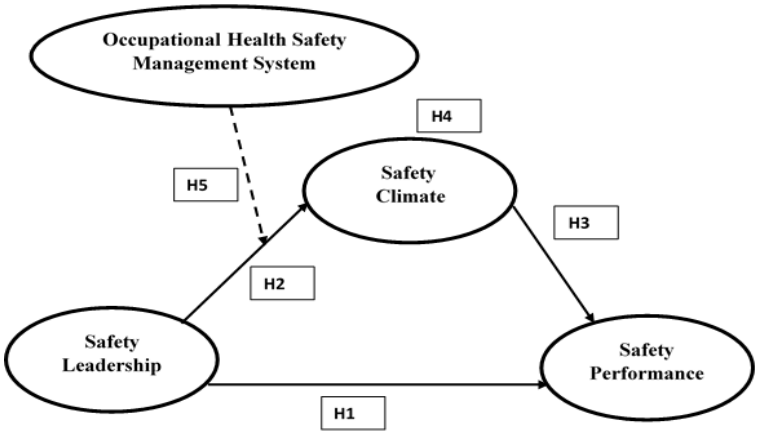


Figure 1: Conceptual Model

METHODS

The research focuses on construction firms in Nepal. Respondents are frontline people in hydropower (project managers, contractors, consultants, site engineers, and safety engineers). Out of 350 questionnaires distributed, the researcher received only 307 filled responses. This study exceeds the minimum sample size requirement of 20, as each variable has 10 responses based on the number of the latent variable (Wolf *et al.,* 2013). Personal e-mail and direct face-to-face interviews, as well as social applications like email, were the tools functional for data gathering.

Furthermore, several hydropower projects were invited to participate in the study, with site visits arranged for data collection upon their agreement. To measure the model and test the hypotheses, the researcher adapted reflective latent constructs from various prior studies, making necessary modifications to the items to ensure their suitability for the current research framework. The questionnaire comprised five main portions: demography, SCL, SL, OHSMS, and SP. The five-point Likert scale is used in a questionnaire where "1" is strongly agree and "5" is strongly disagree. The questionnaire contained four constructs with 17 items.

Table 1: Demography

Variable	Frequency	%	Variable	Frequency	%
Age class			***Education***		
20-25	159	51.79	Higher Secondary	61	19.87
26-35	119	38.76	Undergraduate	153	49.84
36-45	20	6.52	Graduate	74	24.10
46+	9	2.93	Postgraduate	19	6.19
Work experience (in yrs.)			***Profession***		
1-4	112	36.48	Contractor	117	38.11
5-8	115	37.46	Consultancy	92	29.97
9-12	47	15.31	Project Manager	36	11.73
13+	33	10.75	Engineers (Safety and site)	62	20.20

The Statistical Package for Social Science (SPSS 23.0) and moment structure analysis tool (Amos 21) were selected to perform the data analyses. The analyses involved Structural Equation Modeling (SEM) to determine the fit of the hypothesized model through an examination of two models–the "measurement model" and the "structural model." A measurement model provides the relationship or correspondence between the observed and non-observed variables; a structural model determines the relationship or correspondence between the latent variables with respect to their effect on the dependent variable through a path; that is, a latent variable impacts other latent variables and, therefore, provides an overall measure of the fit of the structural model to the data (Alrowwad *et al.,* 2017).

In addition to the above, there are two components to the SEM design techniques: measurement model testing and structural model fitting. The measurement model is validated with a confirmatory factor analysis, and path analysis uses a latent variable to contribute to the overall measure of the model (Hair *et al.,* 2010).

RESULT

The questionnaire's content validity was confirmed by incorporating scales that had been previously tested and validated for measuring the specified variables. In addition, a panel of experts confirmed validity through a backward–forward translation process. To maintain confidentiality, respondents' identities were kept anonymous, and both other-reports and self-reports were utilized, rather than relying solely on self-reported responses (Azim *et al.,* 2019).

During data screening, a few missing values were identified and replaced with the mean of the corresponding variable (Hair *et al.,* 2006). Additionally, the Durbin-Watson statistic, calculated using SPSS, was close to 2, indicating the absence of autocorrelation in the data (Field, 2009). To achieve more stable parameter estimates and simplify the explanation of the model, researchers use item parcels instead of individual items, a common approach in data analysis (Hau & Marsh, 2004). This study aggregated items from the OHSMS, SL, SCL, and SP constructs into composite variables, as illustrated in Figure 1. Since the data were collected from a single source at a single point in time, common method bias (CMB) was a potential concern (Podsakoff & Organ, 1986). To assess this, Harman's one-factor test was performed using SPSS. The analysis indicated no presence of CMB in the data, as the first factor explained only 26.593% of the variance, which is lower than the 50% benchmark.

The reliability of all constructs surpassed the acceptable threshold for Cronbach's alpha (α) = 0.7, as shown in Table 2, which showed that there is a higher level of consistency, i.e., very good reliability of the construct (Hair *et al.,* 2010).A total of 17 items from four constructs passed the exploratory factor analysis, with a Kaiser–Meyer–Olkin value of 0.822, a significant Bartlett's test of sphericity at 0.000, and the four

constructs explaining 65.923% of the variance, demonstrating an acceptable level of reliability for all constructs.

The average variance extracted (AVE) value in Table 2 is greater than 0.5 as recommended by pioneers (Hair *et al.,* 2010). The square root of each variable's AVE is higher than its correlations with the rest of the variables in the model (Hair *et al.,* 2010). These output values showed a satisfactory level of discriminant validity. In addition, an inspection of the measuring model determines the model is a better fit in terms of demonstrations: CMIN = 262.479, DF (Degree of Freedom) = 113, CMIN / DF = 2.323, GFI = 0.910, standardized fit index (NFI) = 0.920, comparative fit index (CFI) = 0.952, Tucker – Lewis index (TLI) = 0.943, Standardized RMR = 0.0483, root mean square error of approximation (RMSEA) = 0.066 and PCLOSE = .007 (Hair *et al.,* 2019).

Table 2: Reliability and discriminant validity of the measurement model

	CR	AVE	MSV	MaxR(H)	SP	SL	OHSMS	SCL
SP	0.896	0.684	0.045	0.911	**0.827**			
SL	0.927	0.760	0.204	0.933	-0.133	**0.872**		
OHSMS	0.863	0.558	0.010	0.864	-0.100	-0.071	**0.747**	
SCL	0.871	0.629	0.204	0.875	0.211	0.452	-0.044	**0.793**
Mean					2.590	2.610	4.240	2.290
Std. Deviation					0.879	1.003	0.548	0.726
Cronbach's Alpha					0.895	0.926	0.0863	0.870

CR: Construct Reliability. The values highlighted in bold along the main diagonal of the correlation matrix correspond to the square root of the AVE.

As proposed by the model, SCL is theorized as a mediator between SL and SP. Similarly, OHSMS is theorized as a moderator between SL and SCL. The author first implemented bootstrap as suggested by pioneer researchers Fairchild and MacKinnon (2009), to assess the direct effects, indirect effects, and moderation effects within the structural model. 5,000 bootstrapped subsamples were generated with a 95% level of confidence. Subsequently, the structural model was evaluated based on the measurement model. To confirm the established theories of the consuming path coefficient, good, acceptable structural model fit indices were estimated. The output, CMIN / DF = 2.909, GFI = 0.983, standardized fit index (NFI) = 0.864, comparative fit index (CFI) = 0.901, Tucker – Lewis index (TLI) = 0.903, standardized RMR = 0.0534, root mean square error of approximation (RMSEA) = 0.079 and PCLOSE = .009, indicated a strong fit for the overall structural model. Except for the NFI indicator, all other indices indicated a high level of fit for the model.

Table 3: Weights of Coefficients in the Structural Model

Hypothesis	Correlation	Measure	P- value	Conclusion
W1	SL→SP	0.190	0.000***	Validated
W2	SL→SCL	0.305	0.000***	Validated
W3	SCL→SP	0.366	0.000***	Validated
W4	SL→SCL→SP	0.112	0.000***	Validated
W5	OHSMS*SL→SCL	0.093	0.014**	Validated

Note: **p < .05, ***p < .001

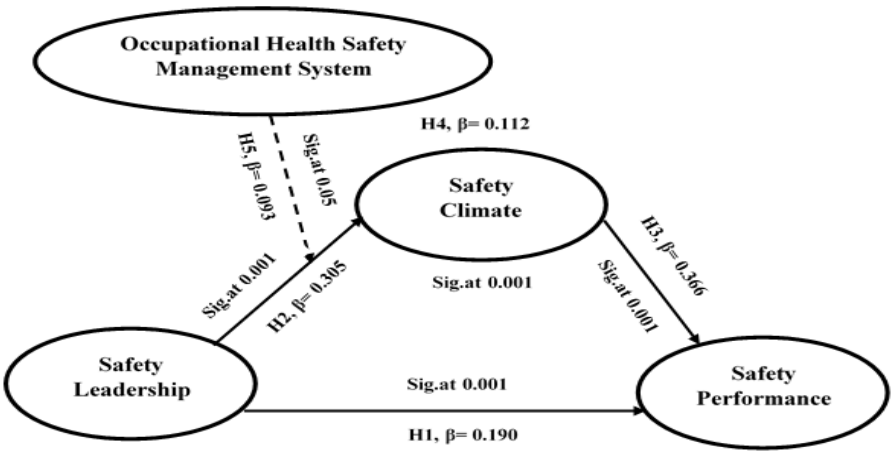


Figure 2: Path Coefficients in Structural Model

DISCUSSION

This research aims to validate the main components that affect safety performance and also look at how SCL acts as a medium, as well as examining how OHSMS affects the attainment of effective and sustainable safety outcomes. Figure 2 demonstrates all major outcomes. The study concluded with the measurement and global structural model fit. All proposed hypotheses were supported at the 1% level of significance except W, which was significant at 5% significance, as shown in Table 3. SL has a positive effect on SP and SCL, which were significant at (f^2=0.190, p<0.001) and W2 (f^2=0.305, p<0.001), respectively. This finding provides strong evidence for the theoretical assertion of,Lingard *et al.,* (2012) that SL has a significant positive effect on SP in any type of firm, supporting the W1 hypothesis. Similarly, many previous studies identify that SL has a significant positive effect on SCL in the petrochemical and coal industry, strongly supporting the W2 hypothesis (Du & Sun, 2012; Wu *et al.,* 2011). Moreover, SCL also has a positive effect on safety performance, which was significant at (f^2=0.366, p<0.001). A prior study finding coincided with our finding that SCL has a strong positive effect on SP in construction firms, supporting the W3 hypothesis (He *et al.,* 2020).

SCL, as mediator, mediated the relationship between SL and SP, which was significant at (f2=0.112, p<0.001). The mediation relation is characterized as complementary partial mediation, since both the direct and indirect effects of SL to SP beta value were in a positive direction,Baron & Kenny, (1986) as shown in Table 3, which was supported by prior studies in petrochemical firms (Wu *et al.,* 2011). The study showed that the indirect effect of SCL for SL on SP was higher than the direct effect of SL for SP (Heaphy *et al.,* 2011). But in this research, the beta value of the direct relation between SL and SP is higher compared to the indirect effect of SL-SCL-SP. An organization's core values influence its occupational safety strategy, which in turn affects both the safety climate and safety performance (DeJoy *et al.,* 2010).

Furthermore, OHSMS as a moderator moderates the relation between SL for SCL, which was significant at (f^2=0.093, p<0.05). This finding strongly supported some theoretical statements, like Kelloway and Barling (2010) those proposed by, which suggested that safety leadership (SL) growth should be a core goal for investigation on involvement in OHSMS. Moreover, earlier studies had revealed that leadership in construction firms was a significant factor for better OHSMS outcomes (Clarke, 2013). Besides, 85% of accidents result from unsafe actions by individuals or groups rather than from unsafe conditions (Walker, 2010). Therefore, safety leadership in OHSMS must extend beyond merely ensuring compliance with regulations.

Similarly, another prior study identified SCL as an important aspect of OHSMS within the workplace (Neal *et al.,* 2000). In addition, rewards as indicators of SCL constructs have a theoretical positive impact on safety participation in OHSMS (Kheng & Khor, 2016). Furthermore, Kim et al. (2019) proposed a strong theoretical declaration that SCL has a positive impact on the proper implementation of OHSMS. The above-mentioned theories supported the W5 hypothesis. The graphical demonstration in Figure 3 noticeably shows the relationships between SL and SCL as moderated by OHSMS. These results determine the significance of OHSMS in improving the effect of SL and SCL.

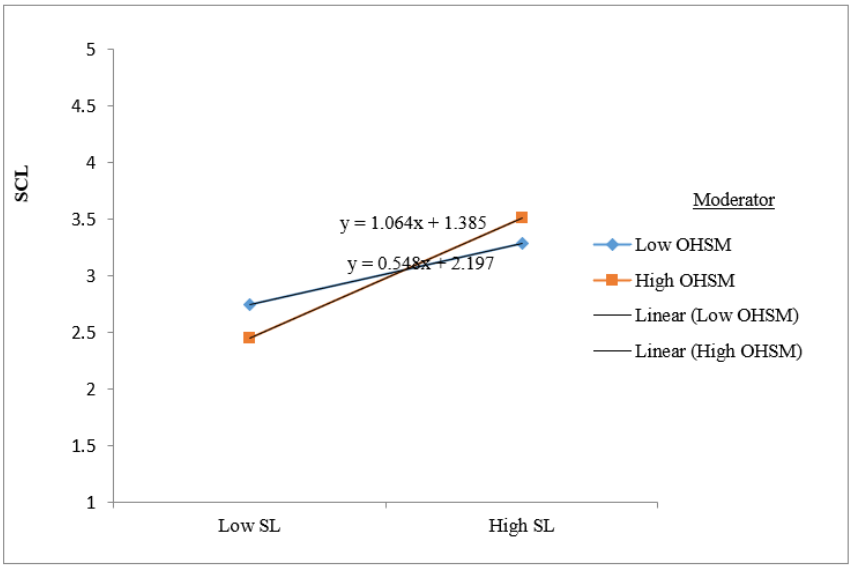


Figure 3: OHSMS tends to improve the relationship between SL and SCL

CONCLUSION

This research's primary objective was to investigate the key predictive constructs that directly, indirectly, and moderately influence SP within Nepal's construction industry. Research shows that SL is helpful for hydropower projects since it makes them more competitive and sustainable by improving safety. Researchers found that safety leadership has a significant positive effect on safety performance in hydropower construction companies. Furthermore, the mediation model indicates that SCL has a comprehensive partial mediating effect on the relationship between SL practices and SP. The study's main contribution is finding that an OHSMS serves as a crucial moderator in this relationship. The interaction analysis demonstrates that the positive effect of SL on SP is amplified when an organization actively promotes an OHSMS. Ultimately, the analysis indicates that the promotion of OHSMS in hydropower projects can lead to improved and sustainable SP, which has profound consequences for developing countries like Nepal.

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