Effect of safety climate & behaviour on safety outcomes between supervisors & workers

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Abstract - *Construction industry is one of the dangerous industries in the world due to safety related injuries and accidents. It is the one of the largest employment sector in US and also the most dangerous one. In India also it is the one of the largest employment sector. Improving safety performance in construction projects is a major concern all over the world. We need to understand the safety performance in terms of safety behavior because of the unavailability of reliable data such as accident statistics. This study compared the safety climate, safety behaviour (safety compliance and safety participation), and safety outcomes (injuries, unsafe events, and stress) between two social groups. Also discussing the difference between safety climate and safety outcome The relationships among these variables were also contrasted with each other using the structural equation modelling (SEM) technique.*

Key Words: **(Safety climate, Safety behaviour, Safety outcome, Cronbach's alpha test, Structural equation modelling (SEM), SPSS Software, comparative analysis)**

1.INTRODUCTION

Construction industry is one of the dangerous industries in the world due to safety related injuries and accidents. It is the one of the largest employment sector in US and also the most dangerous one. In India also it is the one of the largest employment sector where 17.62 million people work in construction sector as per survey of national sample survey organization in 1999-2000.

According to Ministry of Housing and Urban-Rural Development of China (MHURD 2018), 807 construction fatalities and 692 accidents where occurred in 2017. In Ontario 26.6% of workplace trauma related fatalities were from construction sector. No of people dying in Indian construction sector could range from 11640-22080. 24.2% of occupational fatality occurring annually in India is from construction section alone.

Improving safety performance in construction projects is a major concern all over the world. We need to understand the safety performance in terms of safety behavior because of the unavailability of reliable data such as accident statistics. The unsafe worker behavior and actions are accounts for more than 80-95% of accidents. The safety behavior and safety climate play an important role in safety performance.

Safety climate is the term describing the values of shared perception, beliefs and procedures connected to the safety of the organization. It is the key factor which is implicating the promotion of injury-reducing behavior and also safe work environments. It helps to predict the individual safety behavior and also to evaluating and improving the safety of construction sites.

Safety behavior is the actions of employees when they are obeying the safety procedures.it is described by two terms they are safety compliance and safety participation. Safety compliance and safety participation are the safety related actions and behavior correspondingly. The actions such that observing the regulations and complying with the safety related instructions. The behaviors are like attending the safety related training classes and suggesting new ideas about safety.

Safety outcomes comprises the injuries, unsafe events, and stress. The physical aspects of safety outcomes described in terms of injuries and unsafe events. Cut or puncture, headache and eye injury are the example for it. Stress due to the dangerous work environment, job demand, group work style are leads to some types psychological outcomes such as sadness, anxiety, anger and tension. The employees which are suffering from these kind of psychological outcomes are tend to some types psychological outcomes such as sadness, anxiety, anger and tension. These employees which are under psychological stress will not have proper concentration in work and they feel strained.

This study compared the safety climate, safety behaviour (safety compliance and safety participation), and safety outcomes (injuries, unsafe events, and stress) between two social groups. Also discussing the difference between safety climate and safety outcome The relationships among these variables were also contrasted with each other using the structural equation modelling (SEM) technique.

1.1 Factors

Safety climate factors are mainly 6 types. They are management commitment, safety perception, co-worker safety perception, safety knowledge, work pressure, role overload.

Safety behaviours are two types. They are safety compliance behaviour and safety participation behaviour

Safety outcomes are three types. They are injuries, stress, events. Each of them is widely classified

1.2 Objectives

- To identify the outcomes percentage occurring in site
- To identify the percentage of response for each factors
- To calculate the mean and error of each factors
- To calculate the reliability of questionnaire
- To calculate the difference of safety performance and safety climate.
- To analyses the relationship between the 3 factors using SEM technique.

From above objectives the major objectives are calculate the percentage of response for each item, calculating the difference of safety performance and safety climate and analyzing the relationship between safety climate, safety behaviour and safety outcome using structural equation modelling.

1.3 Scope

•Study the relationship between the three factors.

•Study the relationship between safety climate and safety performance

•Reduce the overall safety outcomes of the worksite

The main scopes are the first two points. These studies are identifying the factors relationship and it will helpful to reduce the safety outcomes.

2. METHODOLOGY

The aim of this study is comparing the safety climate, safety behaviour and safety outcomes between supervisors and construction workers. The construction companies are considered for the data collection.

The methodology selected for this research includes a questionnaire design, questionnaire survey of the construction workers and supervisors. Also the survey data are analyzed using structural equation modelling. The methodology used for this project is shown in figure

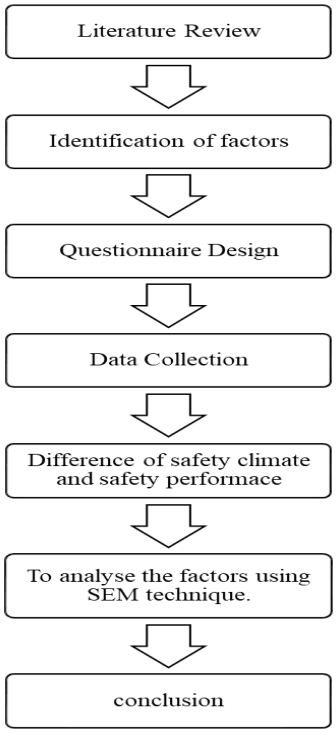

Fig -1: Research methodology

2.1 Questionnaire Design

The questionnaire was designed based on the literature study and detailed examination. The questionnaire consists of two parts: basic information and main body. The first part is related to demographic information. The second part contains three categories: safety climate, safety behaviour, safety outcome. The questionnaire is mainly based on the safety factors. The questions in the main body is evaluated by five point Likert scale. There were 25 items related to safety climate, 6 items related to safety behaviour and 28 items related to safety outcomes respectively.

2.2 Data Collection

Data collection becomes the essential part of any study. Data accuracy will determine the accuracy of study. Data are collected from the village regions. A total of 153 questionnaires were accepted as an analysis sample. The number of supervisors and site workers were 15 & 138 respectively.

2.3 Data Analysis

For the data analysis first we are checking the reliability and validity of the questionnaire. Reliability is checking by Cronbach's alpha test and validity is checked by convergent and discriminant validity test. Then find the difference in safety climate and safety performance between supervisors and workers. It is done by using analysis of variance. Then finding the relationship between the safety climate, safety behaviour and safety outcome. They were analyzed by using structural equation modelling technique. In SEM 3 types of goodness of fit index are checked.

2.4 SPSS Software

The software SPSS is used for batched and non-batched statistical analysis. SPSS means statistical package for social sciences. The normality, collinearity and variance were checked with SPSS statistics.

2.5 Structural Equation Modeling (SEM)

It is an appropriate technique for multivariable analysis. That combine with factor analysis, path analysis and multiple regression analysis. SEM is widely adopted technique. In this study it is used for examine the hypotheses and find out the relationship between the safety factors. SPSS AMOS is used for it. The relationship between safety behaviour, safety climate and safety outcome are analyzed by structural equation modelling technique. Three type of goodness of index are checked for the model. They are absolute indexes, incremental indexes, and parsimonious indexes.

2.6 Hypothesis

A model is constructing for the analysis. This model is making by some hypotheses. These hypotheses are constructed from some theories.

Safety climate impact on safety climate in three ways. Directly, through mediating variables (stress, safety knowledge, motivation and intention) and through moderating variables (project identify, site layout and work management). So that safety climate has an influential impact on safety behaviour. Here 2 hypotheses are generated.

- Hypothesis 1: Safety climate (SC) is positively associated with safety compliance behaviour (SCB).
- Hypothesis 2: Safety climate is positively associated with safety participation behaviour (SPB).

Both of levels (organization level and group level) safety climate is negatively associated to injury frequency. Safety perception is a mediating role in the relationship between management's perception and worker's injury outcomes. Based on these theories establishing the third hypotheses.

- Hypothesis 3: Safety climate is negatively associated with the following safety outcomes (SO): injuries (H3a), stress (H3b), and unsafe events (H3c).

Safety behaviour can reduce the accidents and mediate the regulatory foci and safety outcome relationship. Safety behaviour has direct impact on safety outcome due to reducing the number of accidents. These theories make the next two hypotheses.

- Hypothesis 4: Safety compliance behaviour is negatively associated with the following safety outcomes: injuries (H4a), stress (H4b), and unsafe events (H4c).
- Hypothesis 5: Safety participation behaviour is negatively associated with the following safety outcomes: injuries (H5a), stress (H5b), and unsafe events (H5c).

Many studies recognized safety participation and safety compliance as two parallel behaviours in safety. These relations will give more information about the worker's mechanisms. So that the next hypothesis is generated here.

- Hypothesis 6: Safety participation behaviour is positively associated with safety compliance behaviour.

The psychological stress leads to more accidents and injuries. The accidents also bring stress disorders like anxiety, guilt etc. The deaths in the sites effect the mental health of other workers. The safety outcome among the unsafe events, injuries and stress are testing by inner links, it will reveal that they may help reverse the deterioration of safety performance. These theories make the last three hypotheses.

- Hypothesis 7: Unsafe events are positively associated with injuries.
- Hypothesis 8: Unsafe events are positively associated with stress.
- Hypothesis 9: Injuries are positively associated with stress

The initial research model is generated by combining above stated hypotheses. The model is shown below.

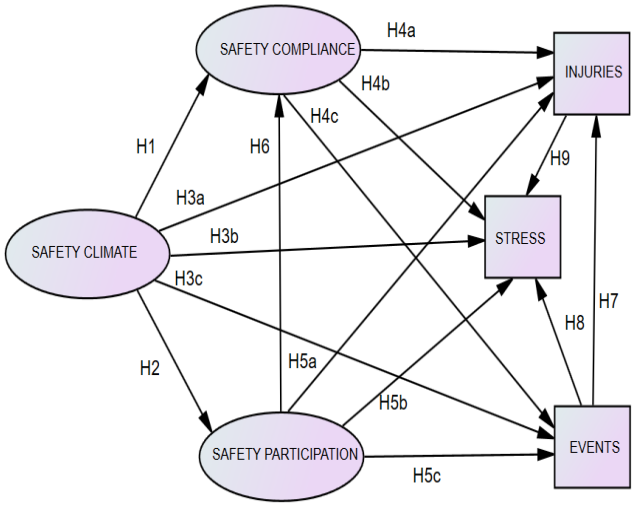

Fig 2: Research model

3. RESULT AND DISCUSSION

For the analysis of SEM models are created for workers and supervisors. Then both of them are explored. Then the structural model fit test are done. The result of index values shows that it is a good fit for both workers and supervisors. After the this test the hypotheses were tested for both workers and supervisors. The result of hypotheses is shown in table 1.

Table 1: hypotheses result of workers and supervisors

	Estimate		S.E.		C.R		p		Hypothesis testing results	
Hypothesis	Worker	supervisor	Worker	supervisor	Worker	supervisor	Worker	supervisor	Worker	supervisor
H1.SC→SCB	-0.032	-0.148	0.675	0.393	-0.374	-1.467	0.709	0.142	Reject	Reject
H2.SC→SPB	0.091	0.559	0.308	0.924	1.071	2.520	0.284	0.012	Reject	Adopt
H3.SC→SO										
H3a.SC→Injuries	0.078	0.191	0.236	0.431	0.931	0.617	0.382	0.537	Reject	Reject
H3b.SC→Stress	-0.113	0.364	0.323	0.517	-1.387	1.874	0.166	0.061	Reject	Accept
H3c.SC→Events	0.057	-0.014	0.107	0.518	0.661	-0.042	0.509	0.966	Reject	Reject
H4.SCB→SO										
H4a.SCB→Injuries	0.059	0.850	0.030	0.279	0.707	1.087	0.480	0.277	Reject	Reject
H4b.SCB→Stress	0.172	0.6622	0.041	0.344	2.108	1.313	0.035	0.189	Adopt	Reject
H4c.SCB→Events	0.048	0.676	0.014	0.328	0.565	0.816	0.572	0.414	Reject	Reject
H5.SPB→SO										
H5a.SPB→Injuries	0.135	-.595	0.065	0.285	1.618	-0.698	0.106	.485	Reject	Reject
H5b.SPB→Stress	0.186	-1.142	0.090	0.343	2.265	-2.127	0.023	0.033	Adopt	Adopt
H5c.SPB→Events	0.023	0.-715	0.029	0.335	0.264	-0.791	0.791	0.429	Reject	Reject
H6.SPB→SCB	0.053	1.024	0.186	0.094	0.616	10.168	0.538	-	Reject	Adopt
H7.Events→Injuries	0.165	0.148	0.189	0.222	1.989	0.599	0.047	0.549	Adopt	Reject
H8.Events→Stress	0.101	0.457	0.261	0.266	1.222	2.953	0.222	0.003	Reject	Adopt
H9.Injuries→Stress	0.071	0.4477	0.117	0.316	0.847	2.703	0.397	0.007	Reject	Adopt

In hypotheses test the p value is considering for the result. When the p value is less than 0.05 the hypothesis is confirmed. The hypotheses supported by the data for the supervisors only were as follows:

- Hypothesis 2: Safety climate is positively associated with safety participation behaviour (SPB).

- Hypothesis 3b: Safety climate is negatively associated with stress (H3b)
- Hypothesis 6: Safety participation behaviour is positively associated with safety compliance behaviour.
- Hypothesis 8: Unsafe events are positively associated with stress.
- Hypothesis 9: Injuries are positively associated with stress

The hypotheses supported by the data for the workers only were as follows:

- Hypothesis 4b: Safety compliance behaviour is negatively associated with the stress (H4b).
- Hypothesis 7: Unsafe events are positively associated with injuries.

Table 2: SEM result of direct, indirect and total effects

		Direct Effects		Indirect effects		Total effects	
Endogenous Variable	Exogenous Variable	Worker	Supervisor	Worker	Supervisor	Worker	Supervisor
SCB	SC	-0.032	-0.148	0.005	0.572	-0.027	0.424
	SPB	0.053	1.024	0	0	0.053	1.024
SPB	SC	0.091	0.559	0	0	0.091	0.559
Injuries	SC	0.078	0.191	0.02	0.01	0.098	0.201
	SCB	0.059	0.85	0.008	0.1	0.067	0.95
	SPB	0.135	-0.595	0.007	0.868	0.142	0.273
	Events	0.165	0.148	0	0	0.165	0.148
Events	SC	0.057	-0.014	0.01	-0.113	0.067	-0.127
	SCB	0.048	0.676	0	0	0.048	0.676
	SPB	0.023	-0.715	0.003	0.693	0.026	-0.022
Stress	SC	-0.113	0.364	0.025	-0.325	-0.088	0.039
	SCB	0.172	0.662	0.01	0.733	0.182	1.395
	SPB	0.186	-1.142	0.022	0.79	0.208	-0.352
	Events	0.101	0.457	0.012	0.066	0.113	0.523
	Injuries	0.071	0.447	0	0	0.071	0.447

The hypotheses that were supported by the data for both group were the following:

- Hypothesis 5b: Safety participation behaviour is negatively associated with stress (H5b).

Due to the measurement of error the indirect effect is not analyzed using regression methods. It can assess by SEM. This process result is shown in table 2.

4. CONCLUSIONS

This paper includes the relations of supervisors and workers in different safety factors. Some relation is common for both groups and also some data are supported only in supervisors and some data are supported by workers. It depends on the management, and safety procedures and safety rule. The relations are differed when the locality features are differed.

REFERENCES

1 Abowitz, D. A., and T. M. Toole. 2010. "Mixed method research: Fundamental issues of design, validity, and reliability in construction research." *Journal of. Construction engineering and Management*. 136 (1): 108–116.

2 Aryee, S., and H. H. Hsiung. 2016. "Regulatory focus and safety outcomes: An examination of the mediating influence of safety behavior." Science direct. 86 (Jul): 27–35.

3 Brenda Y. McCabe. et al. (2017). "Safety performance in the construction industry: Quasi-Longitudinal study." *American society of civil engineers,* 143(4):04016113

4 Changquan He. et al. (2020). "Effect of safety climate and safety behavior on safety outcomes between supervisors and construction workers."*American society of civil engineers,*146(1):04019092

5 Dongping Fang. et al. (2015). "Impact of the supervisor on worker safety behavior in construction projects." *American society of civil engineers,* 31(6):04015001

6 Fang, D., Y. Chen, and L. Wong. 2006. "Safety climate in construction industry: A case study in Hong Kong." *Journal of construction engineering and management*. 132 (6): 573–584

7 Fang, D., C. Wu, and H. Wu. 2015. "Impact of the supervisor on worker safety behavior in construction projects." *Journal of construction engineering and management*. 31 (6): 04015001

8 Guo, B. H. W., T. W. Yiu, and V. A. González. 2016. "Predicting safety behavior in the construction industry: Development and test of an integrative model." Science direct. 84 (Apr): 1–11.

9 Helen Lingard. et al. (2019). "Talking safety: health and safety communication and safety climate in subcontracted construction workgroups."*American society of civil engineers,* 145(5):04019029

10 Hsu, I. Y., T. S. Su, C. S. Kao, Y. L. Shu, P. R. Lin, and J. M. Tseng. 2012. "Analysis of business safety performance by structural equation models." Science direct. 50 (1): 1–11.

11 Leung, M. Y., Q. Liang, and P. Olomolaiye. 2016. "Impact of job stressors and stress on the safety behavior and accidents of construction workers." *Journal of construction engineering and management*. 32 (1): 04015019.

12 Liao, P. C., G. Lei, J. W. Xue, and D. Fang. 2015. "Influence of personorganizational fit on construction safety climate." *Journal of construction engineering and management.* 31 (4): 04014049.

13 Lingard, H., T. Cooke, and N. Blismas. 2012. "Do perceptions of supervisors'safety responses mediate the relationship between perceptions of the organizational safety climate and incident rates in the construction supply chain?" *Journal of construction engineering and management*. 138 (2): 234–241.

14 Luz S. Marín, Sc.D and Cora Roelofs, Sc.D. (2017). "Promoting construction supervisors' safety-efficacy to improve safety climate: training intervention trial."*American society of civil engineers,*143(8):04017037

15 Lyu, S., C. K. Hon, A. P. Chan, F. K. Wong, and A. A. Javed. 2018. "Relationships among safety climate, safety behavior, and safety outcomes for ethnic minority construction workers."*international journal of research environmental research and public*. 15 (3): 484.

16 Marín, L. S., and C. Roelofs. 2017. "Promoting construction supervisors' safety-efficacy to improve safety climate: Training intervention trial." *Journal of construction engineering and management* 143 (8): 04017037.

17 McCabe, B. Y., E. Alderman, Y. Chen, D. E. Hyatt, and A. Shahi. 2017. "Safety performance in the construction industry: Quasi-longitudinal study." *Journal of construction engineering and management* 143 (4): 04016113.

18 Mohamed, S. 2002. "Safety climate in construction site environments." *Journal of construction engineering and management*.128 (5): 375–384.

19 Sharon Clarke (2010),"An integrative model of safety climate: Linking psychological climate and work attitudes to individual safety outcomes using meta-analysis." *Journal of occupational and organizational psychology.* 83 (3): 553–578.

20 Teo, E., F. Ling, and A. Chong. 2005. "Framework for project managers to manage construction safety." *International journal of project management*. 23 (4): 329–341.

21 Yutting chen. et al. (2015). "Impact of individual resilience and safety climate on safety performance and psychological stress of construction worers: a case study of the Ontario construction industry." *Journal of safety research,* 61:167-176

22 Zhang, P., N. Li, D. Fang, and H. Wu. 2017. "Supervisor-focused behaviorbased safety method for the construction industry: Case study in Hong Kong." *Journal of construction engineering and management* . 143 (7): 05017009.

23 Zohar, D. 1980. "Safety climate in industrial organizations: Theoretical and applied implications." *Journal of applied psychology*. 65 (1): 96–102. https://doi.org /10.1037/0021-9010.65.1.96.

24 Zohar, D. 2000. "A group-level model of safety climate: Testing the effect of group climate on microaccidents in manufacturing jobs." *Journal of applied psychology*. 85 (4): 587–596.