

PREVALENT CULTURAL VALUES AND ITS EFFECT ON SAFETY ENGINEERING APPROACHES AND ACUTENESS IN CONSTRUCTION SITES-CHENNAI, INDIA

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Abstract- In current scenario, construction sites are recognized as one of the hazardous work places. Working at height is one of the most hazardous situations in construction sites. Majority of the accidents at construction sites are mainly caused by the risk behaviour of the workers. At risk behaviour of the workforce is influenced by safety climate such as attitudes and perceptions are prevailing at construction site. This paper investigates the prevalent cultural values and its effect on safety beliefs, attitudes and perceptions of workforces at construction sites. Two part questionnaire surveys namely: Attitude and perception survey and cultural values survey for workers were conducted at civil engineering construction sites in and around Chennai. The responses obtained from workers for these surveys were analysed through exploratory factor analysis for extraction of factors. Pearson correlations revealed significant and positive correlations among the factors of national cultural values and safety climate of workforce.

Keywords - Construction, Safety Engineering, Risk Behaviour, Factor Analysis, Pearson Correlation

I. INTRODUCTION

Safety climate/culture is a molar perception, attitude and belief of workforces and safety ethics with regard to safety at their work place [1, 2]. At risk behaviour is inherently associated with the accidents at job sites and the safety behaviour is positively correlated to safety climate. Safety behaviours are the results of the prevailing safety climate [3]. Attitude of workforce with regard to safety is guided by their risk perceptions [4]. Safety climate impacts safety behaviour which subsequently impacts the outcome related to safety

[5]. Safety climate has its effect on safety behaviour of work force [6]. Safety climate is a reference frame for paving appropriate safety behaviour [7]. Attitudes and perceptions are greatly predictive of behaviour of workforce in a given condition [8]. Attitudes influence the behavioural intentions and vice versa [9]. Attitudes and perception influence behaviour and unsafe behaviour lead to accidents [10, 11].

Safety climate is an efficient predictor of work place safety behaviour [12]. According to [13], the beliefs are the basis for the attitude and in turn the attitudes guide the intentions of a person to behave in a particular way and in nutshell the behaviour might be construed as a special case of beliefs. Attitude is not the sole element which affects the behaviour although both were correlated in many occasions. A particular attitude is predictive of a particular behaviour whereas the generic behaviour is predictive of set of allied behaviours [14]. Previous studies [15-17] reveal that the national values influence the safety climate. The World Health Organisation (WHO) 2002 asserted that masculinity is harmful to safety and correlation exists between masculinity and risk behaviours [18]. However, the masculinity was not considered as a distinct dimension and it was overlapped with either dimension only. In light of the above, the objective of the current study is twofold. The primary objective is to investigate the relationship between safety climate and cultural values of construction workforces in around Chennai. Secondary is to examine the effect of masculinity on attitudes and perceptions of workforce.

A. National Cultural Values

Four national cultural dimensions as defined by Hofstede [19] are considered for this study. For better understanding, these four cultural values are explained as below in simple terms so that the national culture concept can be explained effortlessly.

- Power distance-Tolerance to inequalities
- Uncertainty avoidance-Tolerance to ambiguities
- Collectivism/Individualism-Degree of cohesiveness among workforce
- Masculinity/Femininity-Distribution values among genders

II. RESEARCH METHODOLOGY

The safety climate and cultural values survey questionnaires used in previous studies is refined appropriately in the regional context. The workforce will have to provide their responses in 5 point likert scale for the statements in safety climate questionnaire. The Exploratory Factor Analysis (EFA) is expected to be exploratory in its own way. Although, it is not required to prescribe hard and fast formula, the following steps shall be taken into consideration to perform EFA [20, 21].

- Data cleaning/screening
- Extraction technique/method
- Number of factors/dimensions
- Rotation technique/method
- Interpretation of factor solutions
- Evaluation of factor solutions for its robustness

Both safety climate and cultural values survey questionnaires have 25 variables per construct. Principal Component Analysis (PCA) with Varimax rotation and Kaiser Normalisation were adopted for this factor analysis and SPSS is used for this EFA. Previous studies were the basis for retaining number and labelling of factors extracted through EFA. The factors were further analysed through the following:

- ANOVA to find whether there is any significant difference in opinion among workers
- Pearson correlation to examine the linearity in relationship among the factors

III. RESULTS AND DISCUSSIONS

A. EFA for Safety Climate

All requisite preliminary analysis like data screening, suitability checks had been done before performing factor analysis and the observed test results are given in Table 1. The results of factor analysis are presented in Table 2.

B. National Cultural Values

As mentioned earlier all requisite preliminary analysis like data screening, suitability checks had been done before performing factor analysis for

national cultural values and the observed test results are given in Table 3.

TABLE 1: SUMMARY OF EFA

S. No	Description of items	Surveys	
		Safety Climate	National Culture
1	Variables count for Factor Analysis	25	25
2	Sample size	130	130
3	Ratio (Cases to Variable)	5.20*	5.20*
4	KMO (Keiser Meyer- Olkin) Statistic	0.854	0.870
5	Bartlett’s test of Sphericity Chi-Square	1306.93	1681.47
6	Degree of Freedom (D _f)	105	171
7	Significance Value (p)	0.000	0.000
8	Number of Factors extracted	3	4
9	Variables retained after Factor Analysis	15	19
10	Total percentage variance explained	70.28%	70.43%

* Rule of Thumb : Minimum 5 Cases required Variable

TABLE 2: SAFETY CLIMATE - FACTOR LOADINGS OF EFA

Factor 1 Awareness & Belief (WAP 1) Variance = 29.455% Eigen value = 4.418, Cronbach’s Alpha = 0.910	Loadings
PPEs are beneficial for safety	0.870
I am aware of safety procedures applicable to my work	0.848
Safety is top priority for management	0.838
Management acts decisively on safety concerns	0.793
Construction sites are dangerous places	0.776
Physical Work Environment (WAP F2) Variance = 24.556% Eigen value = 3.683, Cronbach’s Alpha = 0.901	
I don’t get proper tools to work safely	0.866
I am not entertained to raise safety issues	0.847
It is OK to take shortcuts due to work pressure	0.782
Management does not mind even basic safety concerns	0.769
Certain degree of risk exciting in my work	0.759
No sufficient time to finish work safely	0.712
I seldom concerned about being injured at work site	0.639
Supportive Environment (WAP F3) Variance = 16.269% , Eigen value = 2.440, Cronbach’s Alpha = 0.803	
Management informs safety concerns/issues	0.838
Management does encourage safety feedback of workers/contractors	0.811
Safety training is skill specific	0.710

TABLE 3: NATIONAL CULTURE - FACTOR LOADINGS OF EFA

Factor 1 Power Distance (WNC 1) Variance = 21.929% Eigen value = 4.166, Cronbach's Alpha = 0.894		Load ing
I prefer the organisation which has less stringent safety rules (WNC 5)		0.522
Workers adhere to safety rules without instructions (WNC 6)		0.685
I prefer the company for its pay rates than its safety performance (WNC 7)		0.832
Management encourages me to report safety issues (WNC 8)		0.828
I can act authoritatively if I found something unsafe (WNC 9)		0.848
I prefer to associate with bigger organisations (WNC 10)		0.728
Factor 2 – Masculinity (WNC F2) Variance = 20.535 % Eigen value = 3.902, Cronbach's Alpha = 0.894		
I enjoy the risks related to my job (WNC 3)		0.819
Company should own major responsibility towards safety (WNC 2)		0.808
I and my co-workers value a safe workplace (WNC 1)		0.787
Good relationship at worksite is not important for safety (WNC 14)		0.634
Management encourages safety feedback from workforce (WNC 15)		0.663
My safety decisions are effective than co-workers (WNC 16)		0.646
Workers are consulted for site safety plan (WNC 18)		0.508
Factor 3 Collectivism (WNC F3) Variance = 17.057% , Eigen value = 3.241, Cronbach's Alpha = 0.896		
Safety training improves safety attitude (WNC 22)		0.814
Co-workers must support my safe work behaviour (WNC 23)		0.882
Co-workers share safety tips to each other (WNC 24)		0.841
Supervisors loses esteem if he seeks for workers input (WNC 25)		0.805
Factor 4 – Uncertainty Avoidance (WNC F4) Variance = 10.912% , Eigen value = 2.073, Cronbach's Alpha = 0.846		
Accidents happen, we can't avoid them (WNC 20)		0.847
Safety rules should not be overruled (WNC 21)		0.820

C. ANOVA-One Way

There were five categories of workforces responded in the survey namely Scaffolder, Carpenter, Steel fixer, Concreter and Mason. Hence, the one way ANOVA is performed to examine whether there is any statistically significant difference in opinions of the workforces. The results for all three factors of safety climate survey and four factors of national cultural surveys revealed that there is no significant different exists among five categories of workforce. The results with along with its significance values are presented in Table 4 and Table 5 respectively.

The significant values for all factors are well above 0.005.

TABLE 4: ANALYSIS OF VARIANCE-FOR SAFETY CLIMATE

ANOVA									
Factors		Scaffolder	Carpenter	Steel Fixer	Concreter	Mason	Total	F Ratio	Sig.
Awareness & Beliefs (WAP-1)	Me an SD N	4.275 0.943 24	4.281 1.396 27	3.900 1.050 26	4.133 1.058 27	3.785 1.002 26	4.074 1.107 130	0.000	0.379
Physical Environment (WAP-2)	Me an SD N	2.804 0.188 24	2.778 0.323 27	2.775 0.311 26	2.746 0.325 27	2.835 0.258 26	2.787 0.285 130	0.992	0.838
Support Environment (WAP-3)	Me an SD N	3.542 0.563 24	3.691 0.577 27	3.641 0.659 26	3.543 0.548 27	3.462 0.633 26	3.577 0.594 130	4.217	0.658

TABLE 5: ANALYSIS OF VARIANCE-FOR NATIONAL CULTURE

ANOVA									
Factors		Scaffolder	Carpenter	Steel Fixer	Concreter	Mason	Total	F Ratio	Sig.
Power Distance (WNC-1)	Me an SD N	3.805 0.919 24	3.652 1.095 27	3.785 0.905 26	3.563 0.852 27	3.500 0.972 26	3.603 0.944 130	0.401	0.808
Masculinity (WNC-2)	Me an SD N	3.065 0.671 24	3.063 0.955 27	3.022 0.703 26	3.032 0.651 27	2.973 0.818 26	3.031 0.759 130	0.062	0.993
Collectivism (WNC-3)	Me an SD N	4.958 0.550 24	5.148 0.753 27	4.821 0.767 26	4.790 1.038 27	5.051 0.644 26	4.954 0.774 130	1.024	0.397
Uncertainty Avoidance (WNC-4)		2.514 0.481 24	2.556 0.443 27	2.372 0.288 26	2.309 0.357 27	2.462 0.433 26	2.441 0.409 130	1.661	0.163

D. Pearson Correlation

Pearson correlation is performed to examine the linear relationship among the factors of safety climate and national culture. The results revealed that all four factors of national cultures are significantly and positively correlated with all three factors of national climate and the results are presented in Table 6.

TABLE 6: PEARSON CORRELATION AMONG SAFETY CLIMATE AND NATIONAL CULTURE FACTORS

Factors	Description	Power Distance (WNC-1)	Masculinity (WNC-2)	Collectivism (WNC-3)	Uncertainty Avoidance (WNC-4)
Awareness & Beliefs (WAP-1)	Pearson Correlation	0.675**	0.718**	0.406**	0.305**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	130	130	130	130
Physical Environment (WAP-2)	Pearson Correlation	0.312**	0.385**	0.540**	0.224*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	130	130	130	130
Support Environment (WAP-3)	Pearson Correlation	0.385**	0.402**	0.463**	0.239**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	130	130	130	130
** Correlation in Significant at the 0.01 level (2-tailed)					
* Correlation in Significant at the 0.05 level (2-tailed)					

- Power distance (PD) factor of national culture correlated positively and significantly with all the three factors of safety culture. Power distance correlated strongly, positively and significantly with awareness and beliefs. Power distance correlated significantly with moderately positive relationship with physical and support environments. The power is centralised and hence the workforces rely more on the supervisors and formal directions. The workforce favours this environment as they expect to be given directions to do the work safely and this situation calls for adequate number of supervisory and safety personnel.
- The masculinity factor of national culture also correlated positively and significantly with all the three factors of safety culture. Masculinity exhibited strong, positive and significant correlation with awareness and beliefs. Masculinity correlated significantly with moderately positive relationship with physical and support environments. It means the workforces are moderately assertive and hardworking by nature. The masculinity is thoroughly associated with risk inclination. Hence, in this environment, the workforce tends to act cautiously in accordance with rules to ensure safety compliance.
- Collectivism factor of national culture also exhibited significant and moderately positive correlations with all the three factors of safety culture. This condition reveals the presence of reasonable level of faith in collective decision and good grip over the work and site conditions. In this environment, the workforce feels that accident prevention is a shared responsibility. The workforce maintains conducive atmosphere

through good relationship and shares safety precautions with each other. This collectivist environment favours safety training through regular skill specific trainings on safe work procedures /practices. It is common that the collectivism co-exists along with power distance environment.

- Uncertainty Avoidance factor of national culture also exhibited significant and moderately positive correlations with all the three factors of safety culture. This state of affairs manifests that the workforce learnt to live with uncertainties and they feel free from fear of uncertain events as they hold reasonable degree of safety awareness. The workforces in this environment are rule abiding people and they will not break the safety rules even if the rules would not work always. This is in line with the findings of the previous study [22].

IV. CONCLUSION

This study investigated the relationship amongst national cultural values and safety climate of attitude and perceptions on workforce engaged in civil engineering projects sites in around Chennai city. The physical work environment factor is greatly influenced by power distance and masculinity factors. The inequality among the management and workforce is evidenced. The workforces have the tendency to behave cautiously and ensure the safety compliance. The vast majority of workforces are not affected by uncertainties and they learnt to live with it and hence moderate risks are handled effectively. The workforces have reasonable degree of safety awareness and believe that prevention of accidents at worksite is the collective responsibility. Further, collectivist attitude is evidenced among the workforces who favour safety training through regular skill specific trainings on safe work procedures /practices. The masculinity attitudes prevalent among the workforce encourage them to take calculative risks so as to strike balance between and productivity and safety to the reasonable extent. It is to conclude that the attitudes and perceptions of the workforce towards safety is influenced by the all the four cultural values to the reasonable extent. It is very much pertinent that the commitment of management towards safety and cooperation of workforce to ensure safety compliance is evidenced and thus it exhibits safe work ethics and behaviours among the work forces.

REFERENCES

- Brown, R.L. and Homes, H. "The use of a factor analytic procedure for assessing the validity of an employee safety climate model", *Accident Analysis and Prevention*, vol. 18, no. 6, pp. 455-470, 1986.
- Cox, S. and Cox, T. "The structure of employee attitude to safety-a European example", *Work and Stress*, vol. 5, no. 2, pp. 93-106.
- Mohamed, S. "Safety climate in construction site environments", *ACSE Journal of Construction Engineering and Management*, vol. 128, no. 5, pp. 375-383, 2002.

- [4] Tam, W.Y.V., Mohamed, S. and Ali, T.H. “National culture and safe work behaviour of construction workers in Pakistan”, *Safety Science*, vol. 47, pp. 29-35, 2009.
- [5] Guldenmond, F.W. “The nature of safety culture-a review of theory and research”, *Safety Science*, vol. 34, pp. 215-257, 2000.
- [6] Diaz, R.I. and Cabrera, D.D. “Safety climate and attitude as evaluation measures of organisation safety”, *Accident Analysis & Prevention*, vol. 29, no. 5, pp. 643-650, 1991.
- [7] Zohar, D. “Safety climate in industrial organizations: theoretical and applied implications”, *Journal of Applied Psychology*, vol. 65, no. 1, pp. 96-102, 1980.
- [8] Toole, T.M. “The relationship between employees perceptions of safety and organisational culture”, *Journal of Safety Research*, vol. 33, pp. 231-243, 2002.
- [9] Rundmo T. and Hale, A.R. “Managers attitudes towards safety and accident prevention”, *Safety Science*, vol. 41, pp. 557-574, 2003.
- [10] S. Nallusamy, “Overall performance improvement of a small scale venture using critical key performance indicators”, *International Journal of Engineering Research in Africa*, vol. 27, pp. 158-166, 2016.
- [11] Coyle, I, Saleeman, S.D. and Adams, N. “Safety climate”, *Journal of Safety Research*, vol. 26, pp. 247-254, 1995.
- [12] Khandhan, M., Maryam. M., Shahram, V. and Amir, K. “Safety climate and prediction of ergonomic behaviour”. *International Journal of Occupational Safety and Ergonomics*, vol. 19, no. 4, pp. 523-530, 2013.
- [13] Ajzen, I. and Fishbein, M. *Understanding attitudes and predicting social behaviour*, Prentice Hall, Englewood Cliffs, NJ, 1980.
- [14] Frymer, A.B. and Nadler, M.K. *From persuasion: Integrating theory, research and practice*, 4th edition, Kendall Hunt Publishing, 1991.
- [15] Guha, H. “Construction safety management climate in Kolkatta, India”, *International Business Research*, vol. 6, no. 8, pp. 68-74, 2013.
- [16] Balakannan, K., Nallusamy, S., Chakraborty, P.S. and Majumdar, G. “Performance evaluation of supply chain and logistics management system using balanced score card for efficiency enhancement in Indian automotive industries”, *Indian Journal of Science and Technology*, vol. 9, no. 35, pp. 1-9, 2016.
- [17] Tauha, H. Ali. *Influence of national culture on construction safety climate in Pakistan*. Unpublished Ph.D. Thesis, School of Engineering, Griffith University, Gold Coast Campus, Australia, 2006.
- [18] Rawlinson, F. and Farrell, P. *Construction: a culture for concern?* In Dainty, A (Ed) Proceedings 24th Annual ARCOM Conference, Cardiff, UK, Association of Researchers in Construction Management, pp. 1093-1102, 2008.
- [19] Hofstede, G., Hofstede, G.J. and Minkov, M. *Cultures and organizations. Software of the mind, Intercultural cooperation and importance for survival*. Mc. Graw Hill Publications, 2010.
- [20] Jason, W. Osborne. *Best practices in exploratory factor analysis*, Scots Valley, CA, Create Space Independent Publishing Platform, 2014.
- [21] Hair, J., Anderson, R., Black, W. Barry and Ralph, E. Anderson. *Multivariate data analysis*. 8th Edition Prentice Hall International INC, New Jersey, 2019.
- [22] Thirugnana Sambandan, V. and Felix Kala, T. “Investigation on national culture orientations and construction engineering safety culture”, *International Journal of Advanced Research in Engineering and Technology*, vol. 11, no. 6, pp. 720-730, 2020.