Factors influencing Electrical Occupational Accidents A Statistical Analysis of Kerala, India

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Abstract

A research survey is conducted in a large public electric utility in the State of Kerala, India. A safety survey with 3017 participants is the largest in that electrical utility. The objective of the research is to find out the relationships between personal factors and occupational accidents. Five personal factors and five safety climate factors were identified for the study. Analyzing the data revealed a significant correlation between these factors.

Hence, it is clear that personal factors are playing a vital role in accident causation. So, this investigation helps to find out the major factors influencing occupational accidents like job stress, social support and self-esteem.

Keywords: Safety climate, Self-esteem, Safety motivation, Personal factors, Regression Statistics.

Introduction

Occupational accidents make major loss everywhere in the world[28]. Losses by these accidents are not fully countable[2]. Every accident is negatively affecting the economy of the nation[20] and the morale of the work force[25]. Preventing accidents is the best method and globally accepted[1]. Lessons learnt from the accidents can be used for preventing the re-occurrence of the incidents and finding the root causes.[33,36].

According to theories of accident causation, accidents are occurred by the unsafe act, unsafe condition and unforeseen hand[40,44]. An unsafe act is considered as the major reason for almost all the accidents[14,38,39]. Researchers also focused on the main factors influencing these unsafe acts. Human reliability studies and behaviour studies are in line with this[12,27,37]. We conducted a large occupational safety survey in a public sector electrical utility in the State of Kerala, India. The study concluded with interesting insights.

Every accident causes financial losses, but its after effect is some more severe. Loss of goodwill, loss of potential clients, effects in business relations and loss of work morale are some of them. Accident causation and methods to prevent re-occurrence are well developed. But the human aspects of accident causation are emerging now. This study found important personal factors which influence occupational safety. These relationships are significantly validated and exhibited. Only five personal factors and five safety climate factors are identified in this research. These factors show significant correlations and can be used to predict the safety behaviour of the workers.

Data Sources and Methods

Data Sources: A research survey is conducted in the largest public sector electrical utility in the State of Kerala, India. The instrument for the survey was developed and validated before the main survey. Two pilot surveys are conducted for fine-tuning each question in the instrument.

3379 questionnaires were distributed and 3017 responses were received. This survey was conducted in all the districts of Kerala. Details of the data collected are shown in figure 1. This survey included responses from all the technical staff- from the workers to deputy chief engineers. This classification based on the designation of the respondents is shown in figure 2. Most of the staff are lineman (36.4%).

All the details of the respondents including age, experience, designation etc. are included in table 1. The mean age of the participants is 44 years, which means most of them are in middle age. Mean experience in years is 11.56. The respondents are dominated by males (93.9 %).

Methods: The main factors identified for the study along with the study method are shown in figure 3. We selected 5 personal and 5 safety climate factors for this research survey. Two pilot surveys were administrated before the main one.

Personal factors: Personal factors selected for this study include self-esteem, job stress, personal stress, social support and fatigue score. These factors are identified by conducting a systematic literature review and consultation with domain experts.

Self-esteem: Self-esteem is an important influencing factor in occupational safety behaviour[9,17,41]. It was accessed by Rosenberg self-esteem scale[17].

Job stress: Health and Safety Executive management standards indicator tool is used for measuring job stress.[5,11,32]

Personal stress: Personal stress was measured by the National Education Panel Study by German scale. This scale is modified as per the targeted populations.[19]

Social Support: Social support was measured by the scale developed by adding family problems items and economic problem items.[13,34,42,50]

Fatigue Score: The multidimensional checklist individual strength questionnaire (CIS) was used to measure fatigue score among the workers.[4,31,46]

Safety climate factors: Safety climate and related factors were developed by many studies[15,43,48]. Here we selected five main safety climate factors for the study, these are safety participation, safety compliance, safety training safety knowledge and safety motivation.

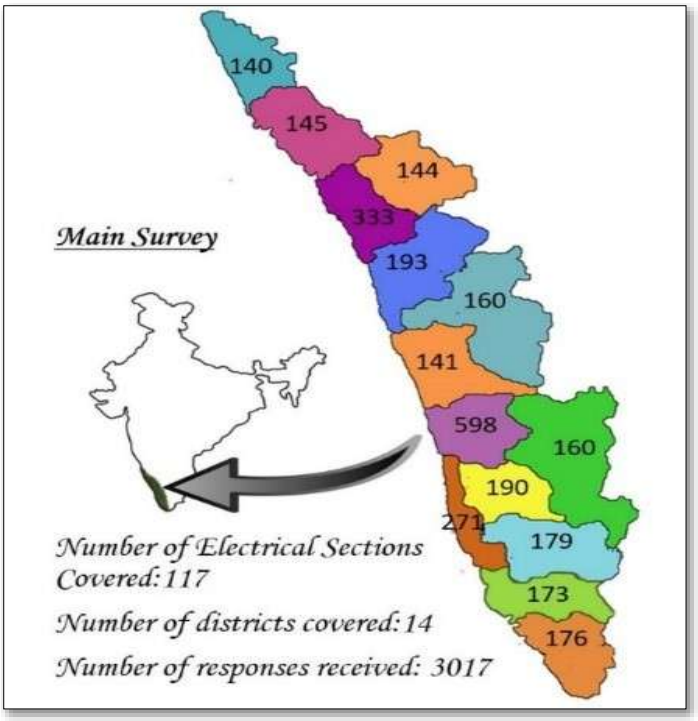

Fig. 1: Response Map of the Survey

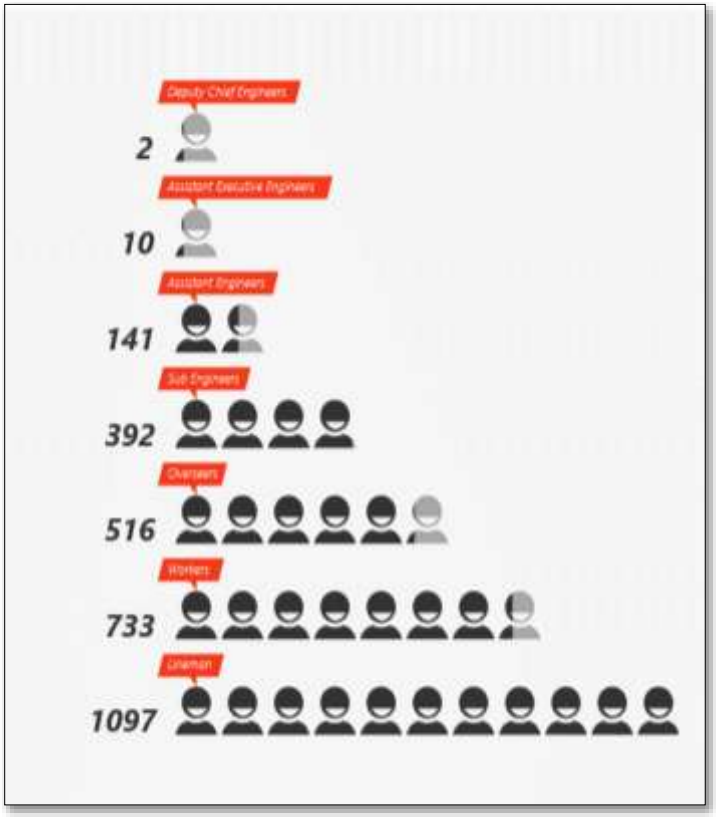

Fig. 2: Details of the sample as per designation

Table 1
Final participants details (N= 3017)

Details	Number	Percent (%)
Gender		
Male	2834	93.9
Female	183	6.1
Age (Mean 44Yrs)		
21 ~ 34	281	9.31
35 ~ 44	1355	44.9
45 ~ 54	1217	40.3
55 ~ 63	164	5.44
Experience (Mean 11.56Yrs)		
0~5	475	15.7
6~10	898	29.8
11~15	932	30.9
16~20	362	12
21~25	330	10.9
26~38	20	.66
Work Position		
Temporary Staff	126	4.2
Worker	733	24.3
Lineman	1097	36.4
Overseer	516	17.1
Sub Engineers	392	13.0
Asst. Engineers	141	4.73
Asst. Executive Engineers	10	.33
Deputy Chief Engineers	2	.066

Fig. 3: Factors identified for the study

Scales for measuring these factors are well developed, we modified scales developed by researchers and some of the items were modified[8,35,47]. Descriptive validity, convergent validity, face validity and reliability of the instrument are significantly checked.

Results and Discussion

Reliability and Validity Analysis: SPSS software version 26 is used for the reliability and validity analysis[16,49]. Principal component analysis with varimax rotation is used for factorisation[23,51]. The loading factor cut selected is 0.3[29]. KMO value for the model is 0.907, Bartlett Value is 53771.942, degree of freedom 780, p<.0005. this indicates factors are correlated[26] .

The mean Cronbach alpha for the scale is 0.817 which was above the accepted value[26]. Thus internal consistency method was used for checking the reliability of the selected items[22]. Spilt half reliability for personal factors and safety climate factors was found (>.84). Details of these reliability and validity tests are shown in table 2.

Confirmatory factor analysis: Confirmatory factor analysis (CFA) was conducted to check how well the measured variables represent the constructs[7,10,11,18,45]. Chi-square value to the degree of freedom ratio is varying from 2.3 to 5.08. For a large number of samples, this is just satisfactory. CFA is conducted by splitting the data into 20, 50, 75 and 100 percentages.

Comparative fit index is .901 to .950. Tucker Lewis index is .89 to .94, RMSEA is 0.41 to .037 and Goodness of fit 0.9 to .940, SRMR is .047 to .025. P of close fit is 1. These values indicated that the model has the best fit.

Convergent validity: The results for the convergent validity test are indicated in table 4. All the items have a factor loading of more than 0.6[29]. Composite reliability for the constructs is more than 0.7 (.8 - .851). The average variance extracted value is more than 0.5. These results indicated that the model has the best convergent validity.

Discriminant Validity: Conditions for discriminant validity are fully satisfied and are shown in table 3[24]. The square root of AVE for all the constructs is more than cross-correlations with other constructs MSV as less than AVE values.

Relationship between personal factors and safety climate factors: A correlation test between the personal factors and safety climate factors was carried out. Results are shown in table 5. Some of the important correlations are explained below.

Safety motivation and Fatigue score: The correlation between safety motivation and fatigue score was shown in figure 4. Fatigue in the workplace is negatively affecting the safety motivation (r (3017) = -.207, r2 = .042, p< .001). So the employer must take reasonable measures to reduce fatigue in the workplace and to improve safety motivation. Fatigue can be reduced in several ways like adjustig the shift pattern, implementing job rotation, frequent breaks etc. These findings are in line with the other researchers.[6,30,37]

Safety motivation v/s Personal stress: The correlation between safety motivation and personal stress was shown in figure 5. Personal stress is negatively affecting the safety motivation (r (3017) = -.152, r2 = .023, p< .001). This indicates that interventions to reduce personal stress must be included in a workplace like- celebrations, counseling etc.

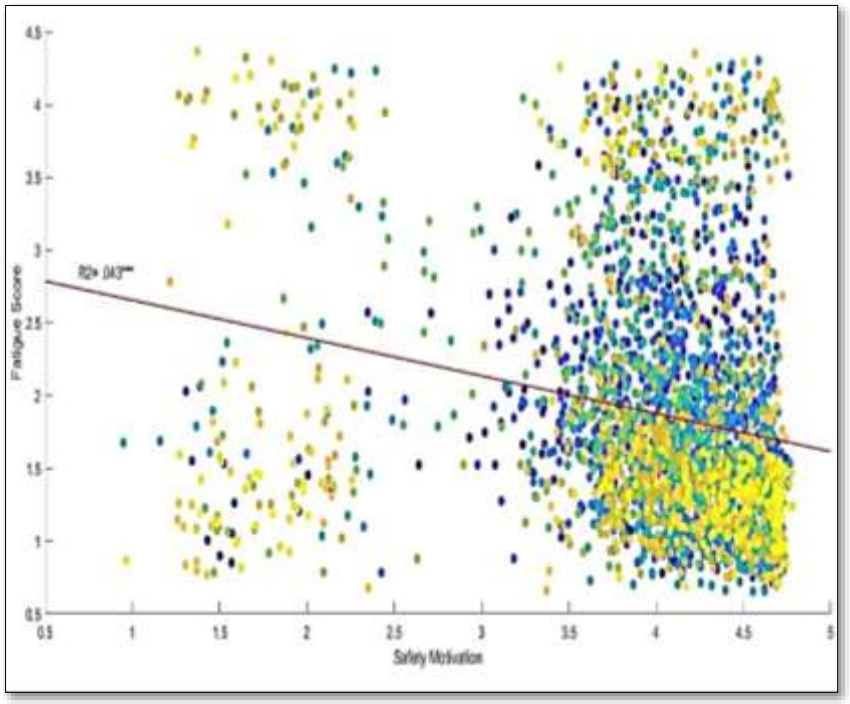

Fig. 4: Safety motivation v/s Fatigue

Safety motivation v/s social support: Social support is an important influencing factor in human life. Correlation between safety motivation and social supporting is also negative r (3017) = -.141, r2 = .023, p< .001). Social support can be increased by conducting family meetings, get together etc. This relationship is shown in figure 6.

Safety participation and Fatigue score: The correlation between safety participation and fatigue score was shown in figure 7. Fatigue in the workplace is negatively affecting the safety participation (r (3017) = -.243, r2 = .059, p< .001). To improve the safety culture of an organization, safety participation is an inevitable thing. So fatigue should be avoided in the workplace.

Safety participation v/s Personal stress: Correlation between safety participation and personal stress was shown in figure 8. Personal stress is negatively affecting the safety participation (r (3017) = -.251, r2 = .063, p< .001).

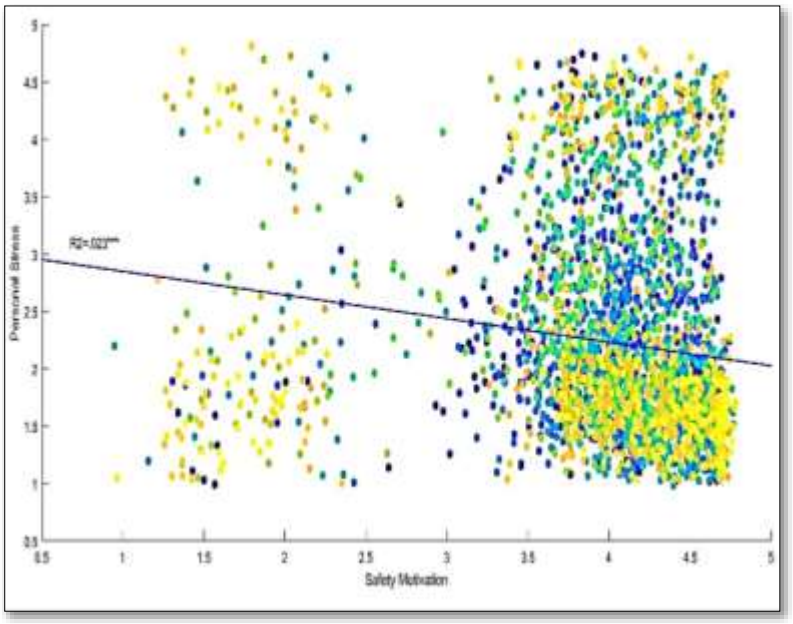

Fig. 5: Safety motivation v/s personal stress

Table 2
Descriptive Statistics, Reliability and Correlations for Study Variables

	Mean	SD	1	2	3	4	5	6	7	8	9	10
Safety Factors												
1.Safety Participation	4.36	0.74	(.820)									
2.Safety Compliance	4.33	0.74	.371**	(.840)								
3.Safety Training	4.12	0.92	.326**	.448**	(.797)							
4.Safety Knowledge	4.32	0.74	.377**	.483**	.476**	(.837)						
5.Safety Motivation	4.26	0.81	.330**	.314**	.340**	.521**	(.805)					
Personal Factors												
6.Personal Stress	2.39	1.11	-.165**	-.121**	-.179**	-.149**	-.105**	(.802)				
7.Fatigue	2.25	1.06	-.179**	-.144**	-.191**	-.157**	-.155**	.483**	(.799)			
8.Social Support	2.34	1.11	-.228**	-.123**	-.191**	-.136**	-.108**	.477**	.454**	(.810)		
9.Job Stress	1.99	0.99	-.420**	-.241**	-.204**	-.247**	-.226**	.390**	.290**	.333**	(.838)	
10.Self Esteem	4.33	0.76	.371**	.262**	.243**	.322**	.245**	-.169**	-.172**	-.198**	-.316**	(.818)

Values in brackets are Cronbach alpha coefficients. *significant level p < .05, **significant level p < .01

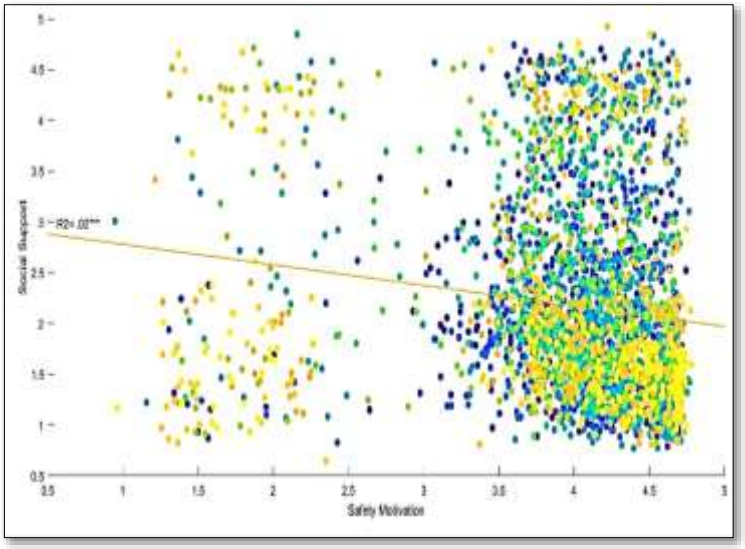

Fig. 6: Safety motivation v/s social support

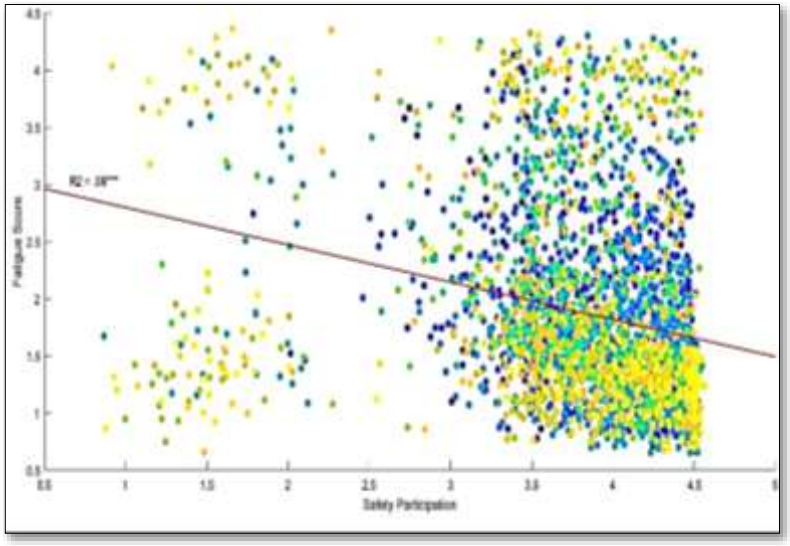

Fig. 7: Safety participation v/s fatigue score

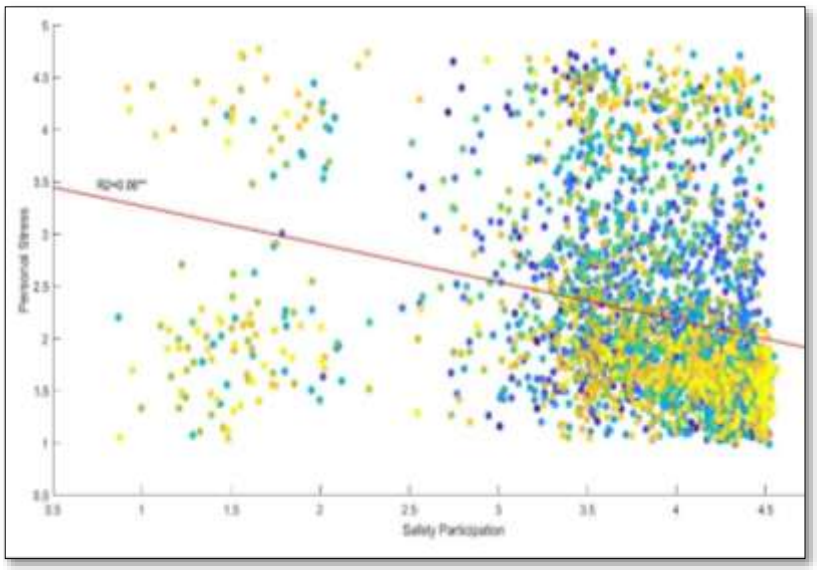

Fig. 8: Safety participation v/s personal stress

Safety participation v/s social support: Correlation between safety participation and social supporting is also negative r (3017) = -.310, r2 = .096, p< .001). These three personal factors play a crucial role in accident causation as in figure 9.

Inter correlation within the factor groups: Inter correlation within the safety climate factors was plotted. Results were found interesting.

Safety motivation v/s safety participation and safety knowledge: These factors are positively correlated. Providing safety knowledge and safety participation are essential for safety motivation. This driving force will help workers to behave safely in the workplace. The relation is demonstrated in figure 10.

Safety motivation v/s safety participation and safety training: These factors are closely related to each other positively. Lack of safety training and safety participation will lead to reduced safety motivation. Variation is revealed in figure 11.

Fatigue score v/s personal stress and job stress: These factors behave like contributing factors- one causing the other. Detailed research can be conducted to reveal their interrelationships. We can see that fatigue's score increased by increasing in stress faced by the worker as in figure 12.

Social support v/s job stress and personal stress: Job stress and personal stress faced by the workers are varying by the level of their social support. The plot (figure 13) demonstrated that the increase in lack of social support is the major reason for stress in the workers.

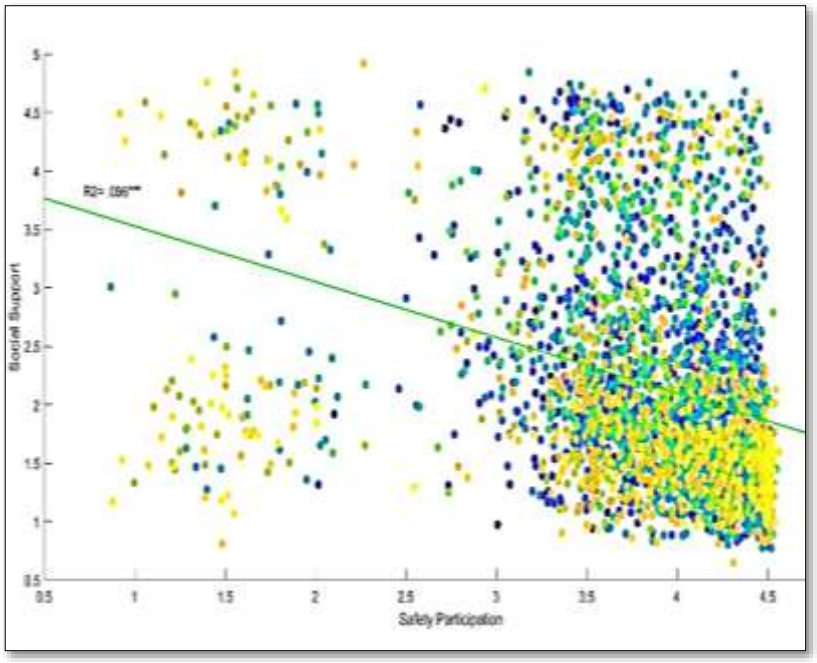

Fig. 9: Safety participation v/s social support

Table 3
Discriminant validity of all variables.

	AVE	MSV	SK	JS	SC	SE	SM	SI	SP	FT	ST	PS
SK	0.564	0.429	**0.751**									
JS	0.592	0.275	-0.311	**0.770**								
SC	0.568	0.329	0.574	-0.300	**0.754**							
SE	0.539	0.209	0.395	-0.368	0.317	**0.734**						
SM	0.520	0.429	0.655	-0.290	0.407	0.311	**0.721**					
SS	0.519	0.362	-0.164	0.391	-0.150	-0.234	-0.144	**0.720**				
SP	0.537	0.275	0.454	-0.524	0.453	0.457	0.413	-0.284	**0.733**			
FT	0.500	0.381	-0.191	0.340	-0.177	-0.207	-0.201	0.563	-0.222	**0.707**		
ST	0.512	0.338	0.581	-0.262	0.552	0.306	0.418	-0.238	0.405	-0.243	**0.716**	
PS	0.529	0.381	-0.202	0.468	-0.171	-0.216	-0.143	0.602	-0.223	0.617	-0.238	**0.728**

Note; SK: Safety Knowledge, JS: Job Stress, SC: Safety Compliance, SE: Self-Esteem, SM: Safety Motivation, SS: Social Support, SP: Safety Participation, FT: Fatigue Score, ST: Safety Training, PS: Personal Stress

Table 4
The result of convergent validity of overall measurement model.

Variable	Item	Loading Factor	Composite Reliability (CR)	Average variance extracted (AVE)
Safety Knowledge	SK1	.702	0.838	0.564
	SK2	.782		
	SK3	.743		
	SK3	.736		
Safety Compliance	SC1	.721	0.840	0.568
	SC2	.792		
	SC3	.761		
	SC4	.730		
Safety Motivation	SM1	.735	0.811	0.520
	SM2	.765		
	SM3	.647		
	SM4	.682		
Safety Participation	SP1	.717	0.822	0.537
	SP2	.712		
	SP3	.722		
	SP4	.713		
Safety Training	ST1	.506	0.805	0.512
	ST2	.778		
	ST3	.778		
	ST4	.685		
Job Stress	JS1	.614	0.851	0.592
	JS2	.883		
	JS3	.660		
	JS4	.893		
Self Esteem	SE1	.770	0.822	0.539
	SE2	.772		
	SE3	.746		
	SE4	.613		
Social Support	SS1	.656	0.811	0.519
	SS2	.679		
	SS3	.774		
	SS4	.757		
Fatigue	FT1	.735	0.800	0.500
	FT2	.686		
	FT3	.670		
	FT4	.741		
Personal Stress	PS1	.714	0.815	0.529
	PS2	.707		
	PS3	.661		
	PS4	.686		

From the statistical analysis, it is evident that personal factors are significantly influencing all the selected safety climate factors. Two important inter correlations are explained below:

Safety participation v/s job stress, personal stress: Stress is negatively influencing the safety behaviour of the worker. It is evident from this study as in figure 14. Personal problems faced by the workers have impacts in their works place. Safety participation can be elevated by reducing the stress faced by the workforce.

Safety participation v/s job stress, self-esteem: Self-esteem is the only personal factor that is positively correlated to safety climate factors in this study (figure 15). Even if the person facing job stress and good self-esteem supports his safety participation, Self-esteem can be developed by conducting personality development programs for the workers.

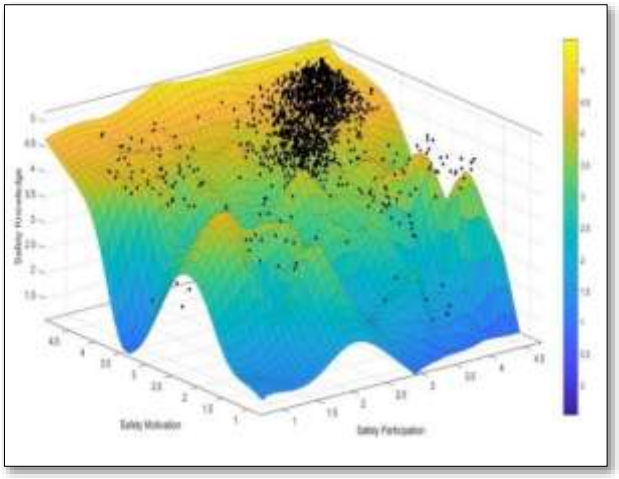

Fig. 10: Safety motivation v/s safety participation and safety knowledge

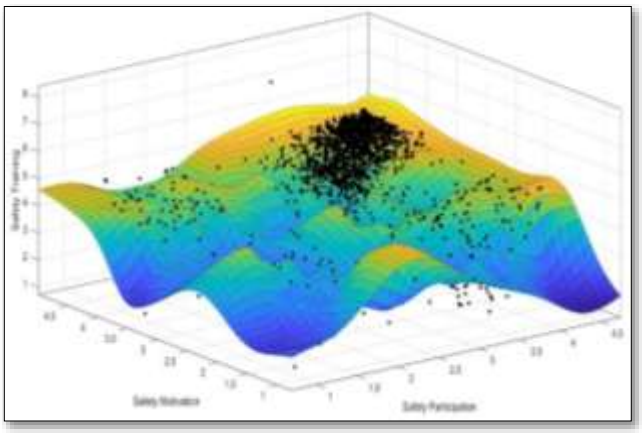

Fig. 11: Safety motivation v/s safety participation

Table 5
Correlation table and safety training

Factors	Mean	SD	SK	ST	SP	SM	SC	FT	PS	SI	SE	JS	TSS
SK	4.18	0.64											
ST	4.21	0.85	.667***										
SP	3.85	0.64	.512***	.472***									
SM	4.02	0.68	.727***	.487***	.462***								
SC	3.92	0.62	.640***	.644***	.505***	.451***							
FT	1.87	0.86	-.202***	-.289***	-.243***	-.207***	-.173***						
PS	2.23	0.93	-.217***	-.274***	-.251***	-.152***	-.180***	.702***					
SS	2.17	0.98	-.166***	-.280***	-.310***	-.141***	-.138***	.643***	.685***				
SE	4.06	0.69	.442***	.356***	.516***	.348***	.352***	-.229***	-.241***	-.258***			
JS	1.27	0.80	-.318***	-.312***	-.574***	-.294***	-.287***	.354***	.520***	.408***	-.404***		
TSS	21.38	2.85	.870***	.820***	.722***	.777***	.794***	-.268***	-.250***	-.248***	.473***	-.424***	
TPS	3.48	3.23	-.341***	-.395***	-.485***	-.289***	-.287***	.800***	.863***	.829***	-.524***	.703***	-.426***

Note; SK: Safety Knowledge, JS: Job Stress, SC: Safety Compliance, SE: Self-Esteem, SM: Safety Motivation, SS: Social Support, SP: Safety Participation, FT: Fatigue Score, ST: Safety Training, PS: Personal Stress, TSS: Total Safety Score, TPS: Total Personal Score ** Significant at p<.01, *** Significant at p<.001

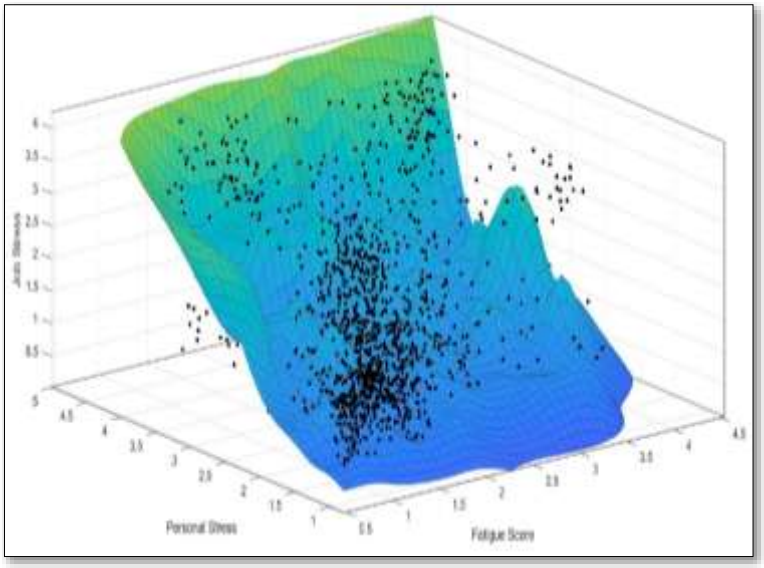

Fig. 12: Fatigue score v/s personal stress and job stress

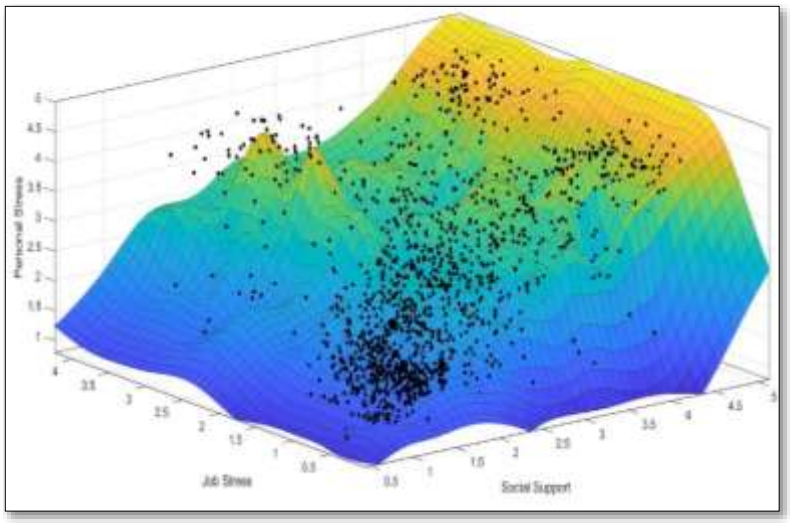

Fig. 13: Social support v/s job stress and personal stress

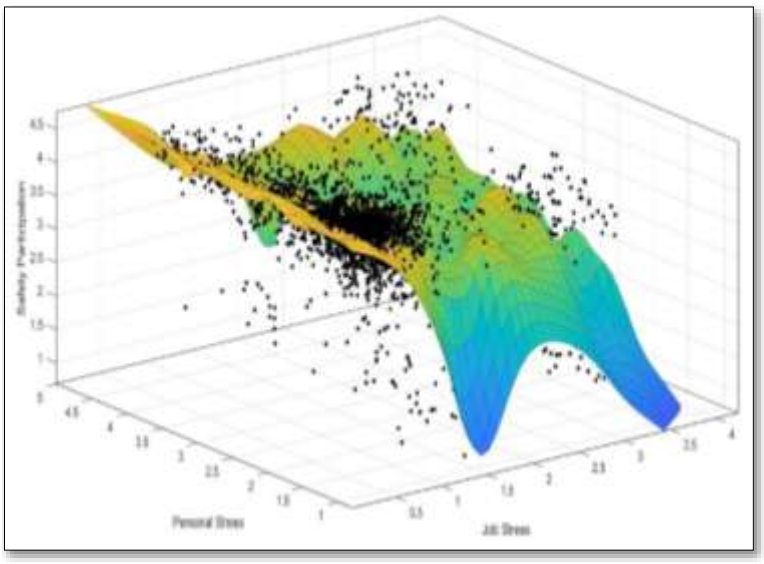

Fig. 14: Safety participation v/s job stress and personal stress

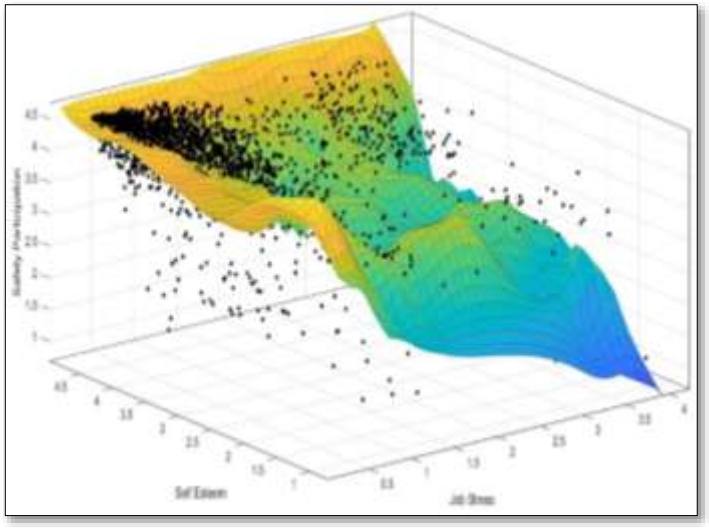

Fig. 15: Safety participation v/s job stress and self-steam

Conclusion

Every accident causes financial losses, but its after effect is some more severe. Loss of goodwill, loss of potential clients, effects in business relations and loss of work morale are some of them. Accident causation and methods to prevent reoccurrence are well developed. But the human aspects of accident causation are emerging now. This study found important personal factors which influence occupational safety. These relationships are significantly validated and exhibited. These findings will be useful to future researchers in the safety domain.

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(Received 02nd June 2021, accepted 01st August 2021)