Assessing Safety Culture and Safety Climate in Electrical Accidents of Utility Sector and Development of Accident Model

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Abstract
A survey was conducted in Electrical utility sector of Kerala in India. The scale for measuring safety culture and safety climate was developed and validated. Safety climate and safety culture was assessed using a five point scale. Three hundred people who are directly exposed to electric safety issues from districts of Kerala are collected. The data was statistically analyzed using reliability analysis, exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and model fit indices (MFI). The measured model indicates a good model fit indices. In the study it was found that safety climate and safety culture are correlated to electrical safety issues. The result showed Safety climate is contributing more to accidents compared to safety culture. This result highlights the need to focus more on the safety climate to reduce electrical safety issues compared to safety culture in the utility sector. This result and findings will provide valuable insight to future research in implementing novel methods to ensure a good safety climate and safety culture in the utility sector.

Keywords: Safety Climate, Safety Culture, Reliability, Factor analysis, Accident model

1. Introduction

Occupational safety issues are the main problem in every industry. In the era of globalization, the use of electricity is high so also the related electrical safety issues. To reduce accidents, it is necessary to have a positive safety culture and safety climate. Many researchers have identified various factors that contribute to safety culture and safety climate to investigate safety outcomes to establish the relation between safety issues, safety climate and safety culture. If the safety issues in the electrical utility sector are kept unnoticed, it leads to electrical fire (Gao and Liu 2016, Asgary et al. 2010) and occupational accidents (Koustellis et al. 2013, Castillo-Rosa et. Al. 2017). Since the risk associated with electrical hazards is more (Chi et. al. 2012, Albert and Hallowell 2013, Khan et al. 2019) it needs special consideration.

The main objective of this study is to analyze whether safety culture and safety climate is correlated to safety issues in the utility sector. To develop an accident model based on the factors contributing to safety climate and safety culture which in turn leads to safety issues in the electrical utility sector. Safety issues are fatal accidents, nonfatal accidents, near misses and damage to equipment/ devices. To develop an accident model and to validate the model using model fit indices for checking whether the model is a good fit model. Also to find which factor is contributing more to electrical safety issues.

2. Literature Survey

The term safety climate and safety culture are used to refer nature of organizational policy and employees' attitudes toward safety issues [12, 39, 23, 56]. Safety culture is referred to individual and group beliefs, knowledge, competency, behavior patterns and attitudes [19, 24 and 37]. It also defines the efficiency of organizational safety and commitment [Industrial atomic energy agency, 1991]. Safety climate is how individuals see procedures, practices and safety rules at work (Griffin & Neal, 2000). Safety climate is how people in an organization perceive safety in their working environment (Zohar, 1980).

Safety climate is different in a different types of industries (Alruqi. et. al; 2010). Safety climate refers to organizational factors and environment which relate to the set of values of the organization while safety culture enhances safety performance by making people aware of accident hazards and their prevention (Guldenmund, 2000; He et al, 2012; Ismail, 2012). In high-risk industrial sectors safety, climate and safety culture are investigated to improve safety performance (Hamid, Cheyne and Cox; Kasim, Emami and Danaee, Hassan, 2019). Safety climate is the perception of employees regarding workplace safety and how it is managed [10, 16 and 41].

Safety climate is regarded as an individual attribute that opposes organizational attributes (James and Johns, 1974). The measure of safety climate reflects the perception of employees about safe conduct in their occupation (Zohar D, 1980). Management can influence the improving safety climate by focusing on effective training programs and decreasing hard work. [40]. Safety climate depends on psychological phenomena and keeps on changing [26]. Safety climate is evaluated to access potential problems in the workplace to enhance safety behavior and decrease the severity of the accident and their frequency [61].

Safety culture endures value and priority to work, workplace and public safety (Zhang et al.). It also refers to how individuals and groups are committed to personal responsibility to work safely. [42, 60]. Good safety culture provides a safer working environment for people working with electrical equipment. Continuous improvement in safety culture is necessary to improve electrical safety [15]. Establishing a safety culture increases the safety performance of workers. Human behavior and safe work knowledge have a strong influence on electrical safety. [14].

A high-level safety culture helps to reduce psychological hazards since it improves the safety performance of the employee. [18]. Safety performance is the safety management of a system which involves controlled output and is measured by safety training evaluation, safety equipment, incident investigation and measure of accident statistics (Yang C C). [57].The safety culture started after the incident, of Chernobyl in 1986 (Yorio et al) [58]. Safety culture is the set of shared values, behavior and perception of employees in the organization. Organizational policies, procedures and practices have an impact on the risk of the hazard. [17]. Safety culture helps to assist performance and stress like involvement, work environment and management commitment. Management commitment helps to reduce stress and injury and improve employee skills. [55]. Griffin and Neal (2000) have not addressed the relationship and between safety culture and safety climate.

Table 1: Literature on items influencing Safety Culture factor

Sl No	Items (Indicator Variables)	Literature
1	Rules & Regulations	Rimal & Real 2003, Kamp & Krause 1997
2	Safety Attitude	Stansfed 1998, Raouf & Dhillon
3	Commercial Pressure	T L Yip, D Jin, W K Talley 2015
4	Management commitment	Rana M Van Tuyl 2021, Byrom & Corbridge 1997, Cox & Cheyne 2000,Cynthia 2005,Huang 2006,

Table 2: Literature on items influencing Safety Climate factors

Sl No	Items (Indicator Variables)	Literature
1	Negligence	Bowander 1987, Lan 2004,Isla Diaz & Diaz Cabrera 1997
2	Attitude	Raouf & Dhillon, Lan 2004, Zohar 1980, Niskanen 1994, Coyle 1995,Isla Diaz & Diaz1 Cabrera 1997, Cynthia 2005,Vinod Kumar & Bhasi 2009,He 2010
3	Participation	Metin Bayram, Bulent Arpat, Yilmaz Ozkan 2021, Cox & Cheyne 2000,Lee 1998,Dedobbeleer & Beland 1991,Cynthia 2005,Zhang 2009,Vinod Kumar & Bhasi 2009,Barbaranelli 2015
4	Peer Pressure	Guillaume Alinier, Mohamud Varjee 2015,Rana M Van Tuyl 2021, Flin 2000
5	Stress	Rana M Van Tuyl 2021, Flin 2000, Lee 1998
6	PPE usage	Reason 1990, Kelm 2013, Hamid 2008, Wong, Wang, Law & Lo 2016, Siv Shingman Saad, Alabdulkarim, Alan Hoi Shouchan, Tingru Zhang 2021, Radwa Sehsah, Abdel Ateya 2020, Galuh Afanti, Dian R Sawitri, 2017
7	Specific Behaviour	J Mullen 2004, Byrom & Corbridge 1997,He 2010
8	Work plan	Fever 1997, cox 1998,Cox & Cox 199
9	Precondition for unsafe act/Prevention Strategy/ Risk preparation	Isla Diaz & Diaz Cabrera 1997,Zhang 2009,Ye 2014
10	Unsafe act	Mc Kinnon 2013
11	Site safety	Rana M Van Tuyl 2021, Cox & Cox 1991,Vinod Kumar & Bhasi 2009,Barbaranelli 2015,
12	Lack of monitoring/ Leadership attention	Hayes 1998,Zhang 2009,Ye 2014, Kelm 2013
13	Insufficient inspection	Saeed Givehchi Ehsan Hemmativaghef, Hassn Hoveidi 2017
14	Lack of proper maintenance	OSHA 1989

15	Poor record keeping	Rana M Van Tuyl 2021
16	Safety effort	S Cox, T Cox 1991,Barbaranelli 2015,
17	Reporting system	Mc Kinnon 2013, Zohar 1980, Rundmo 1992,Rana M Van Tuyl 2021,Byrom & Corbridge 1999,
18	Audit/ Risk Assessment	Zou 2011, T Luo, C Wu, L Duan 2018, Williamson 1997,Zhang 2009, Barbaranelli 2015
19	Physical Damage/ Risk	Lee 1998,Givechchi 2017
20	Monitoring system	Flin 2000,Barbaranelli 2015,
21	Investigation	Beriha 2012,Barbaranelli 2015
22	Chain of command error	Rana M Van Tuyl 2021,Ye 2014,
23	Type of organization	Flin 2000, Lan 2004,Givechchi 2017
24	Motivation	Huey Wen Lim, Nan Li, Dongping Fang, Chunlin Wc 2018, J Mullen 2004, Williamson 1997, Wong, Man & Chan 2020,
25	Management support	Rana M Van Tuyl 2021,Glendon & Stanton 2000, Lan 2004, Brown & Holmes 1986,Dedobbeleer & Beland 1991,Zhang 2009,Barbaranelli 2015,Givechchi 2017
26	Communication	Byrom & Corbridge 1999, Cox & Cheyne 2000, Neal 2000,Isla Diaz & Diaz Cabrera 1997,Cynthia 2005,Ye 2014,Barbaranelli 2015
27	Supervision	Lockley 2007, Flin 2000, Lan 2004,Ye 2014,Barbaranelli 2015
28	Type of job/project	Rana M Van Tuyl 2021,Lan 2004,Barbaranelli 2015,

Understanding and developing a positive safety attitude reduces accidents in the workplace since anxiety and anger result in huge costs or burdens to the organization [21, 25, and 1]. Few managers say that there is no commitment to the rule of safety (Joung et. al.). [30]. It is the professional and legal responsibility to have a safe and healthy working environment. The working environmental policies and procedures are needed to ensure geed safety and health in the workplace. [33]. Work involvement means promoting and supporting employees in safety matters of the workplace [43]. Psychological hazards occur due to the strong influence of perception, gender, experience, work stress, violence and bullying in the workplace. [5, 8, 35, 36, 49]. Some of the factors contributing to safety culture and safety climate is shown in table 1 and 2.

Structural Equation Modeling (SEM) is a multivariate method to determine the validity of competing hypotheses and to gather samples concerning a theory or concept [11, 31, 45, and 47]. Structural equation modelling finds application in engineering, management, economics, operation research, social science, education research etc. [22, 27, 34 and 46]. SEM is a powerful statistical tool for the assessment and modification of theoretical models. The confirmatory factor analysis helps to build the measurement part of the model where the relationship between construct and latent factors is studied [13, 20, 28, and 38]. Confirmatory factor analysis is based on hypotheses while exploratory factor analysis is derived from data and is verified. Exploratory factor analysis analyzes the nature of latent construct and the relation between measured variables and latent factors. Confirmatory factor analysis helps to inspect how indicator variables represent latent factors. AMOS is a multivariable statistical software used to construct a model based on acquired data, test the model as well as compare several alternative models [44, 51]. To validate the model, model indices namely Chi-square/degree of freedom, Adjusted Goodness of fit, Parsimony Goodness of fit, Normed fit index, Parsimony normed fit index, Root-mean-square mean approximation and Root mean square residual is found. If the indices value is in the acceptable range we can conclude that the model is a best fit one.

3. Materials and Methods

In the study of Electrical safety issues due to safety culture and safety climate in the utility sector, a questionnaire survey method was used. The items under study was taken from literature (Table 1and 2).The questions were taken from the literature and modified for the study. A Pilot study was conducted on 100 respondents who are directly connected with safety issues. Eight items were considered under safety culture and fifty-seven items were considered under safety climate. The pilot study was validated based on the response. Hence 200 more responses were collected by face-to-face interaction from respondents of each district of Kerala. Out of the total 300 responses, 291 response was considered for the final study since 9 of the respondents were not ready to answer all questions. For each item, one question was asked and the score was on 5 points Likert scale. These responses were used in Structural Equation Modeling using SPSS and SPSS AMOS 22. The framework of Structural equation modelling was represented in figure1.

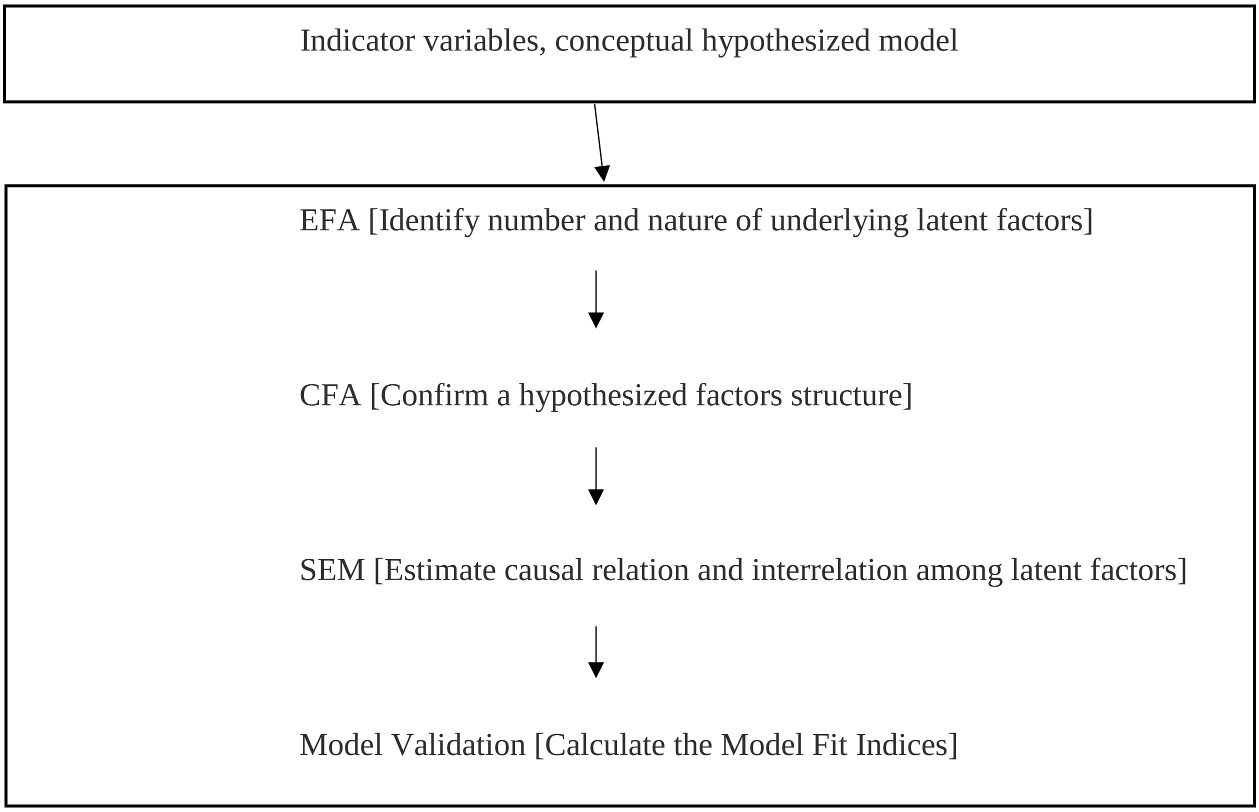

Figure1: Framework of Structural Equation Modelling

The indicator variables consist of eight items contributing directly to Safety Culture and fifty-seven items contributing to Safety Climate which in turn contributes to Safety issues indirectly. Out of the eight items only, four items from Safety culture and out of fifty-seven items only twenty-six items from Safety climate were found to be contributing to a good model based on the pilot study. So in the Structural Equation modelling, thirty indicator variables were considered. The indicator variables and their representation is shown in table 3 and 4.

Table 3: Factors influencing Safety Culture (Scu) and their representation

Sl No	Items (Indicator Variables)	Representation
1	Rules & Regulations	Cu3
2	Safety Attitude	Cu6
3	Commercial Pressure	Cu7
4	Management commitment	Cu8

Table 4: Factors influencing Safety Climate (Scl) and their representation

Sl No	Items (Indicator Variables)	Representation	Sl No	Items	Representation
1	Negligence	(Cl1)	15	Poor record keeping	(Cl29)
2	Attitude	(Cl2)	16	Safety effort	(Cl31)
3	Participation	(Cl3)	17	Reporting system	(Cl34)
4	Peer Pressure	(Cl10)	18	Audit	(Cl38)
5	Stress	(Cl11)	19	Physical Damage	(Cl40)
6	PPE usage	(Cl14)	20	Monitoring system	(Cl42)
7	Specific Behaviour	(Cl17)	21	Investigation	(Cl43)
8	Work plan	(Cl20)	22	Chain of command error	(Cl45)
9	Precondition for unsafe act	(Cl21)	23	Type of organization	(Cl46)
10	Unsafe act	(Cl22)	24	Motivation	(Cl47)
11	Site safety	(Cl23)	25	Management support	(Cl50)
12	Lack of monitoring	(Cl24)	26	Communication	(Cl51)
13	Insufficient inspection	(Cl26)	27	Supervision	(Cl54)
14	Lack of proper maintenance	(Cl27)	28	Type of job/job information	(Cl57)

Safety culture was represented as Scu and Safety Climate was represented as 'Scl'. The Safety issue was represented as SI and the four type of safety issues considered for the study was fatal accident, non-fatal accident, near misses and System damage. The average number of accidents per year in these four categories was collected from respondents and it was also brought to scale. The conceptual model of safety issues is shown in figure2.

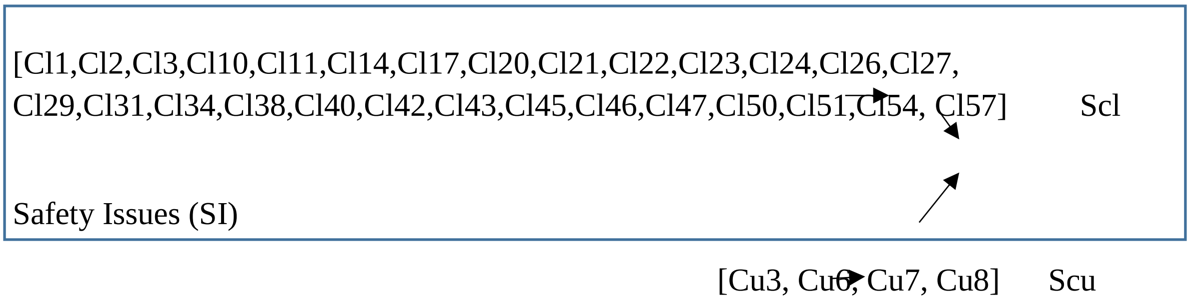

Figure 2: Conceptual model

The Exploratory factor analysis was conducted based on the indicators using SPSS. Using descriptive statistics checked normality by finding skew-ness and kurtosis. According to Brown, 2006 for structural equation modelling analysis the value of skew ness should be within -3 and +3 while kurtosis is between -10 and +10. The factor analysis method is used to reduce the number of factors, and to consider the factor which contributes to safety issues. The reliability of data was found by analyzing the value of Cronbach's alpha (Table 5).

Table 5: Cronbach's alpha value indication

Cron-bac alpha	Remarks
0.9	Excellent
0.8	Good
0.7	Acceptable
0.6	Questionable
0.5	Poor
<0.5	Unacceptable

The reliability of each indicator variable and types of safety issues was found based on Cronbach's alpha value. Also, the value of Cronbach's alpha of standardized items was found. It is an indication of content validity. The correlation was tested by conducting a Chi-square test (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) Table 6 [58]. The significance can be found in the p-value.

Table 6: Kaiser-Meyer-Olkin Measure of Sampling Adequacy (Chi square test) value to test correlation

KMO (Kaiser-Meyer-Olkin) value	Appropriateness in decision making (factor analysis)
0.9	Marvellous
0.8	Meritorious
0.7	Middling
0.6	Mediocre
0.5	Miserable
<0.5	Unacceptable

To extract variables contributing to safety issues, varimax rotation is performed and grouped the variables based on their principal component analysis, the value of communalities and the component matrix. By performing confirmatory factor analysis factor loading was found using SPSS. The correlation test was performed using Hoteling's T-Squared Test and Intra-class Correlation Coefficient (F test) to check if there is a correlation between the safety culture factor and the safety climate factor. The p-value of zero indicates there is no correlation. After confirming the hypothesized factors' structure, the Structural model equation was developed and estimates were found using SPSS AMOS [29]. The regression weight if endogenous variable (factor loading) above 0.7 indicates an excellent model [58].

The variance of the error variable (exogenous variable) is acceptable if the composite reliability CR value is greater than 3 and the p-value is nearly zero. The loading factor of both direct and indirect loading as well as the total effect is also found to check whether the model is acceptable or not (Table 7). If the model is acceptable then the model is validated by finding out the model fit indices, using SPSS AMOS. For a good model the acceptable value of model fit indices is shown in table 8 [32,46,47,48,49,50,51,52,53,54,55,56,57,59].

Table 7 Sample size and factor loading

Sl No	Factor loading	Sample size needed	Factor loading for excellent model
1	0.3	350	>0.65 if sample size more than 100
2	0.35	250	
3	0.4	200	
4	0.45	150	
5	0.5	120	
6	0.55	100	
7	0.60	85	
8	0.65	70	
9	0.70	60	
10	0.75	50	

Table 8: Model fit indices and their acceptable value for a good model

Sl No	Acronym	Explication	Accepted fit	Reference
1	CUMIN/DF	chi square/degree of freedom	<=3-Excellent fit & <=5 Acceptable fit	Kline (1998); Marsh & Hocevar (1985); Hocevar, 1985
2	AGFI	Adjusted Goodness of fit	0.63 TO 0.97, Good fit	Kline (2005); Hu & Bentler (1998); Tabachnick & Fidell (2007)
3	NFI	Normed fit index	0.72 TO 0.99, Good fit	Bentler & Bonett, 1980

4	RMSEA	Root mean square mean approximation	0.00 TO 0.13, Good fit	MacCallum et al (1996)
5	PGFI	Parsimony Goodness of fit	>0.5, Good fit	Tanaka, 1993
6	PNFI	Parsimony normed fit index	>0.5, Good fit	James, Mulaik, & Brett, 1982
7	RMSR	Root mean square residual	0.01 to 0.14, Good fit	Diamantopoulos & Siguaw (2000); Steiger (2007)

4. Result and Discussion

The data was analyzed using SPSS and normality was tested. Both skewness and kurtosis are analyzed using descriptive statistics.

For SEM analysis, the acceptable value of skew ness is -3 to +3 while kurtosis is -10 to +10 (Brown, 2006). From table 9, it is clear that all items have skewness and kurtosis in the acceptable range. The reliability of data was checked by analyzing Cronbach's alpha. From table 10, it is seen that Cronbach's alpha value is greater than 0.862 (>0.8) which indicates the data is good as per literature (table 5).

Table 9: Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance	Skew ness		Kurtosis	
Items	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Cu 3	291	4	1	5	3.92	.573	.328	-1.002	.143	3.774	.285
Cu 6	291	4	1	5	3.91	.546	.298	-1.081	.143	4.317	.285
Cu 7	291	4	1	5	3.93	.549	.302	-1.047	.143	4.390	.285
Cu 8	291	4	1	5	3.92	.563	.317	-.837	.143	3.403	.285
Cl1	291	2	3	5	4.13	.495	.245	.273	.143	.704	.285
Cl2	291	3	2	5	4.00	.541	.293	-.134	.143	.940	.285
cl3	291	3	2	5	4.05	.510	.260	-.076	.143	1.535	.285
Cl8	291	3	2	5	4.09	.521	.272	-.184	.143	1.924	.285
Cl10	291	3	2	5	3.98	.572	.327	-.226	.143	.837	.285

Cl11	291	2	3	5	4.07	.490	.241	.155	.143	1.096	.285
Cl14	291	3	2	5	4.06	.590	.348	-.318	.143	1.051	.285
Cl17	291	3	2	5	4.08	.526	.277	-.056	.143	1.186	.285
Cl20	291	2	3	5	4.07	.544	.296	.046	.143	.360	.285
Cl21	291	2	3	5	4.03	.504	.254	.065	.143	.961	.285
cl22	291	3	2	5	3.99	.551	.303	-.129	.143	.786	.285
Cl23	291	2	3	5	4.05	.522	.273	.071	.143	.654	.285
Cl24	291	2	3	5	4.02	.535	.286	.016	.143	.535	.285
Cl26	291	2	3	5	4.10	.516	.267	.137	.143	.615	.285
Cl27	291	2	3	5	4.08	.525	.276	.097	.143	.547	.285
Cl29	291	2	3	5	4.05	.552	.304	.027	.143	.290	.285
Cl31	291	2	3	5	4.11	.511	.261	.168	.143	.640	.285
Cl34	291	3	2	5	4.09	.540	.291	-.061	.143	.935	.285
Cl38	291	3	2	5	4.05	.542	.294	-.356	.143	2.009	.285
Cl39	291	2	3	5	4.06	.522	.272	.081	.143	.650	.285
Cl42	291	3	2	5	4.02	.635	.403	-.590	.143	1.410	.285
Cl43	291	3	2	5	4.12	.521	.272	.002	.143	1.169	.285
Cl47	291	3	2	5	4.08	.558	.312	-.212	.143	1.181	.285
Cl51	291	3	2	5	4.08	.546	.298	-.079	.143	.867	.285
Cl54	291	3	2	5	4.08	.529	.280	-.056	.143	1.133	.285
Cl57	291	3	2	5	4.05	.554	.307	-.097	.143	.749	.285
F	291	3	0	3	.28	.601	.362	2.184	.143	4.233	.285

NF	291	6	0	6	1.21	1.651	2.727	1.113	.143	-.057	.285
NM	291	10	0	10	2.11	2.484	6.170	1.006	.143	.007	.285
SD	291	5	0	5	1.47	1.634	2.671	.880	.143	-.424	.285

Table 10: Item and their Cron bach's alpha

Factor	Item representation	Cron bach's Alpha	Factor	Item representation	Cron bach's Alpha
Safety Climate	Cl1	.863	Safety Culture	Cu3	.873
	Cl2	.865		Cu6	.873
	cl3	.864		Cu7	.873
	Cl8	.863		Cu8	.875
	Cl10	.864	Types of accidents	F	.873
	Cl11	.865		NF	.888
	Cl14	.863		NM	.914
	Cl17	.862		SD	.894
	Cl20	.863			
	Cl21	.864			
	cl22	.865			
	Cl23	.864			
	Cl24	.864			
	Cl26	.862			
	Cl27	.863			
	Cl29	.863			
	Cl31	.863			
	Cl34	.863			
	Cl38	.863			
	Cl39	.863			
	Cl42	.862			
	Cl43	.863			
	Cl47	.863			
	Cl51	.863			
	Cl54	.863			
	Cl57	.863			

The reliability statistics shown in table11 indicate that the standardized item has a reliability of 0.871 which is greater than 0.8, hence good reliable data. The correlation between safety issues and items of safety culture and safety climate was tested using the Chi-square test (Kaiser-Meyer-Olkin Measure of Sampling Adequacy value).

Table 11: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items
.871	.950

From the literature for a good correlation KMO value is greater than 0.8 (table 6). From table 12, the obtained value is 0.936 (>0.8) indicating a good correlation between items of safety climate and safety culture with safety issues.

Table 12: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.936
Bartlett's Test of Sphericity	Approx. Chi-Square	8026.550
	df	561
	Sig.	0.000

To extract items (endogenous variables) which influence more safety issues communality test was conducted in SPSS. For better relations, the value of communality should be greater than 0.4 for a sample size above 250. From table 13 it is clear that all the 30 endogenous variable has communalities value greater than 0.4.

Table 13: Communalities

Items	Initial	Extraction	Items	Initial	Extraction
Cu3	1.000	.551	Cl23	1.000	.553
Cu6	1.000	.608	Cl24	1.000	.585
Cu7	1.000	.595	Cl26	1.000	.738
Cu8	1.000	.566	Cl27	1.000	.670
Cl1	1.000	.739	Cl29	1.000	.646
Cl2	1.000	.500	Cl31	1.000	.702
cl3	1.000	.587	Cl34	1.000	.642
Cl8	1.000	.669	Cl38	1.000	.699
Cl10	1.000	.549	Cl39	1.000	.723
Cl11	1.000	.558	Cl42	1.000	.603
Cl14	1.000	.605	Cl43	1.000	.663
Cl17	1.000	.726	Cl47	1.000	.603
Cl20	1.000	.678	Cl51	1.000	.666
Cl21	1.000	.584	Cl54	1.000	.693
cl22	1.000	.484	Cl57	1.000	.613

The principal factor analysis was conducted to group the data. Based on the component matrix obtained from the principal factor analysis (Table 14) it is clear that there were only two components namely Safety Culture (Component 1) and Safety Climate (component 2). The loading value above 0.7 indicated a good variance or better explained by the variable. From table 14 it is clear that all items have a loading factor greater than 0.7.

Table 14: Component Matrix (two component Extracted)

Items	Component	
	1	2
Cu3		.742
Cu6		.779
Cu7		.771
Cu8		.743
Cl1	.858	
Cl2	.706	
cl3	.765	
Cl8	.816	
Cl10	.741	
Cl11	.742	
Cl14	.777	
Cl17	.852	
Cl20	.822	
Cl21	.760	
cl22	.692	
Cl23	.741	
Cl24	.758	
Cl26	.859	
Cl27	.818	
Cl29	.804	
Cl31	.838	
Cl34	.801	
Cl38	.829	
Cl39	.848	
Cl42	.774	
Cl43	.814	
Cl47	.777	
Cl51	.815	
Cl54	.832	
Cl57	.780	

*Extraction: Principal Component Analysis.

By conducting a Principal component analysis, the total variance explained can be found. This helps to understand which component is influencing more safety issues. From table 15, it is clear that Safety culture (component 1) explains 48.3% while Safety climate (Component 2) explains 55.5%. So to reduce safety issues importance has to be given to safety climate compared to safety culture. The total variance explained by each item is also obtained (table 15). Each item contributes more than 70% based on the total variance explained in the table (table 16).

Table 15: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	16.443	48.362	48.362	16.444	48.362	48.362	16.443	48.316	48.316
2	2.438	7.172	55.534	2.438	7.172	55.534	2.454	7.218	55.534
3	1.505	4.427	59.961						
4	1.125	3.308	63.269						
5	1.075	3.162	66.432						
6	1.020	3.000	69.431						
7	.881	2.593	72.024						
8	.818	2.406	74.430						
9	.716	2.107	76.537						
10	.634	1.866	78.403						
11	.617	1.814	80.217						
12	.581	1.709	81.926						
13	.542	1.595	83.521						
14	.506	1.487	85.008						
15	.481	1.416	86.424						
16	.460	1.354	87.778						
17	.407	1.196	88.975						
18	.370	1.089	90.064						
19	.353	1.038	91.102						
20	.319	.938	92.039						
21	.300	.883	92.922						
22	.291	.856	93.778						
23	.271	.797	94.575						
24	.257	.755	95.330						
25	.233	.684	96.014						
26	.216	.634	96.648						
27	.200	.589	97.238						
28	.197	.579	97.817						
29	.181	.533	98.350						

30	.167	.492	98.843
31	.126	.370	99.212
32	.105	.310	99.522
33	.090	.264	99.786
34	.073	.214	100.000

Table 16: Rotated Component Matrix [Extraction Method: Principal Component Analysis]

Items	Component	
	1	2
Cu3		.742
Cu6		.779
Cu7		.770
Cu8		.739
Cl1	.856	
Cl2	.704	
cl3	.763	
Cl8	.818	
Cl10	.740	
Cl11	.739	
Cl14	.778	
Cl17	.852	
Cl20	.823	
Cl21	.757	
cl22	.689	
Cl23	.739	
Cl24	.755	
Cl26	.858	
Cl27	.818	
Cl29	.803	
Cl31	.838	
Cl34	.801	
Cl38	.832	
Cl39	.849	
Cl42	.772	
Cl43	.814	
Cl47	.777	
Cl51	.816	
Cl54	.833	
Cl57	.782	

The Accident Model was developed (Figure 3) using SPSS AMOS based on the above analysis. The model was tested to validate.

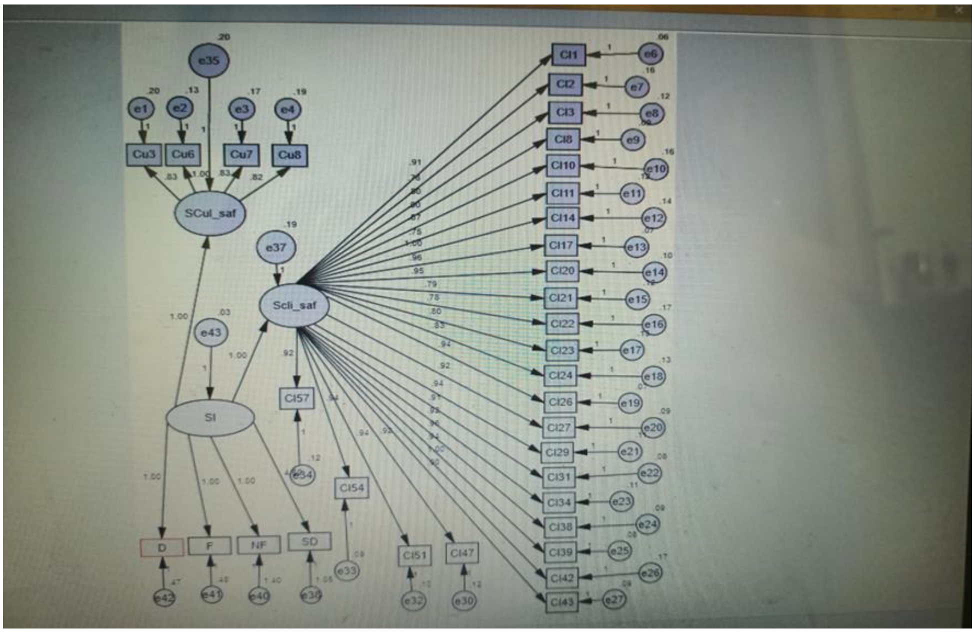

Figure 3: Accident Model- AMOS Model

The regression weight of the endogenous variable was found to be greater than 0.6, indicating good weightage or a better-explained variable (Table 19).It is clear from table 17 and table 18, the factors are independent and there is no correlation between them.

Table 17:Hotelling's T-Squared Test

Hoteling's T-Squared	F	df1	df2	Sig
12070.981	325.425	33	258	.000

Table 18: Intraclass Correlation Coefficient

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.166	.142	.195	7.777	290	9570	0.000
Average Measures	.871	.849	.892	7.777	290	9570	0.000

Table 19: Standardized Regression Weights

Endogenous variable			Estimate	Endogenous variable			Estimate
Cu3	<---	SCul_saf	0.664	Cl23	<---	Scli_saf	0.718
Cu6	<---	SCul_saf	0.797	Cl24	<---	Scli_saf	0.734

Cu7	<---	SCul_saf	0.689	Cl26	<---	Scli_saf	0.859
Cu8	<---	SCul_saf	0.666	Cl27	<---	Scli_saf	0.82
Cl1	<---	Scli_saf	0.86	Cl29	<---	Scli_saf	0.799
Cl2	<---	Scli_saf	0.678	Cl31	<---	Scli_saf	0.84
Cl3	<---	Scli_saf	0.738	Cl34	<---	Scli_saf	0.799
Cl8	<---	Scli_saf	0.817	Cl38	<---	Scli_saf	0.83
Cl10	<---	Scli_saf	0.716	Cl39	<---	Scli_saf	0.851
Cl11	<---	Scli_saf	0.718	Cl42	<---	Scli_saf	0.755
Cl14	<---	Scli_saf	0.782	Cl43	<---	Scli_saf	0.816
Cl17	<---	Scli_saf	0.856	Cl57	<---	Scli_saf	0.779
Cl20	<---	Scli_saf	0.819	Cl54	<---	Scli_saf	0.835
Cl21	<---	Scli_saf	0.738	Cl51	<---	Scli_saf	0.812
Cl22	<---	Scli_saf	0.667	Cl47	<---	Scli_saf	0.777

*The value above 0.6 is acceptable for a good model.

The standard regression weight of accepted items is shown in table 19. The variance explained by the exogenous variables was found. From table 20 is clear that the estimate or weightage is less. The composite reliability CR is greater than 3 and the p-value is zero. This indicates a good model. The standard error is also found to be less for the exogenous variables.

Table 20: Variances

Exogenous variable	Estimate	S.E.	C.R.	P	Label
e43	0.03	0.009	3.304	***	par_29
e35	0.196	0.03	6.518	***	par_30
e37	0.193	0.023	8.295	***	par_31
e1	0.196	0.02	9.712	***	par_32
e2	0.13	0.019	6.928	***	par_33
e3	0.17	0.018	9.342	***	par_34
e4	0.189	0.02	9.681	***	par_35

e6	0.064	0.006	11.293	***	par_36
e7	0.159	0.013	11.818	***	par_37
e8	0.119	0.01	11.728	***	par_38
e9	0.091	0.008	11.517	***	par_39
e10	0.16	0.014	11.766	***	par_40
e11	0.117	0.01	11.762	***	par_41
e12	0.142	0.012	11.633	***	par_42
e13	0.075	0.007	11.321	***	par_43
e14	0.098	0.009	11.506	***	par_44
e15	0.116	0.01	11.727	***	par_45
e16	0.169	0.014	11.832	***	par_46
e17	0.133	0.011	11.762	***	par_47
e18	0.133	0.011	11.736	***	par_48
e19	0.07	0.006	11.301	***	par_49
e20	0.091	0.008	11.505	***	par_50
e21	0.111	0.01	11.578	***	par_51
e22	0.077	0.007	11.411	***	par_52
e23	0.106	0.009	11.577	***	par_53
e24	0.092	0.008	11.459	***	par_54
e25	0.076	0.007	11.353	***	par_55
e26	0.168	0.014	11.698	***	par_56
e27	0.092	0.008	11.521	***	par_57
e38	1.063	0.227	4.692	***	par_58
e40	1.405	0.118	11.901	***	par_59
e41	0.48	0.041	11.563	***	par_60
e42	0.465	0.04	11.545	***	par_61
e34	0.121	0.01	11.636	***	par_62
e32	0.102	0.009	11.533	***	par_63
e30	0.124	0.011	11.642	***	par_64
e33	0.086	0.007	11.439	***	par_65

*Value of CR above 3 & p value<0.01 is acceptable for a good model.

Table 21: Standardized Direct Effects

Factors (Endogenous variables)	Safety Climate	Safety Culture
Cl47	0.777	0
Cl51	0.812	0
Cl54	0.835	0
Cl57	0.779	0
Cl43	0.816	0
Cl42	0.755	0
Cl39	0.851	0
Cl38	0.83	0

Cl34	0.799	0
Cl31	0.84	0
Cl29	0.799	0
Cl27	0.82	0
Cl26	0.859	0
Cl24	0.734	0
Cl23	0.718	0
Cl22	0.667	0
Cl21	0.738	0
Cl20	0.819	0
Cl17	0.856	0
Cl14	0.782	0
Cl11	0.718	0
Cl10	0.716	0
Cl8	0.817	0
Cl3	0.738	0
Cl2	0.678	0
Cl1	0.86	0
Cu8	0	0.666
Cu7	0	0.689
Cu6	0	0.797
Cu3	0	0.664

Table 22: Indirect Effects

Endogenous Variable	Safety Issues	Safety Climate	Safety Culture
Cl47	0.921	0	0
Cl51	0.942	0	0
Cl54	0.939	0	0
Cl57	0.918	0	0
Cl43	0.903	0	0
Cl42	1	0	0
Cl39	0.944	0	0
Cl38	0.957	0	0
Cl34	0.917	0	0
Cl31	0.913	0	0
Cl29	0.937	0	0
Cl27	0.915	0	0
Cl26	0.943	0	0
Cl24	0.833	0	0
Cl23	0.796	0	0

Cl22	0.779	0	0
Cl21	0.79	0	0
Cl20	0.947	0	0
Cl17	0.958	0	0
Cl14	1	0	0
Cl11	0.748	0	0
Cl10	0.869	0	0
Cl8	0.905	0	0
Cl3	0.798	0	0
Cl2	0.779	0	0
Cl1	0.906	0	0
Cu8	0.817	0	0
Cu7	0.826	0	0
Cu6	1	0	0
Cu3	0.828	0	0

The standard effect obtained while testing the model is shown in table 21. It is found that the standard direct effect is greater than 0.65, indicating a good model. Hence the endogenous variable of safety climate and safety culture explains safety issues in a good way, as the four exogenous variables namely Cu3, Cu6, Cu7 and Cu8 are directly connected to safety culture while the other twenty-six variables are directly connected to safety climate.

The four endogenous variables connected to safety culture and twenty-six variables connected to safety climate are indirectly connected to safety issues. Their indirect effect is shown in table 22. It is clear from table 20 that all the endogenous have weightage greater than 0.75 indicating a good model. It is also clear that there is no indirect effect on safety culture and safety climate. So the developed model is correct.

Table 23: Total Effects

	SI	Scli_saf	SCul_saf
Scli_saf	1	0	0
SCul_saf	1	0	0
Cl47	0.921	0.921	0
Cl51	0.942	0.942	0
Cl54	0.939	0.939	0
Cl57	0.918	0.918	0
D	1	0	0
F	1	0	0
NF	1	0	0
SD	4.601	0	0
Cl43	0.903	0.903	0

Cl42	1	1	0
Cl39	0.944	0.944	0
Cl38	0.957	0.957	0
Cl34	0.917	0.917	0
Cl31	0.913	0.913	0
Cl29	0.937	0.937	0
Cl27	0.915	0.915	0
Cl26	0.943	0.943	0
Cl24	0.833	0.833	0
Cl23	0.796	0.796	0
Cl22	0.779	0.779	0
Cl21	0.79	0.79	0
Cl20	0.947	0.947	0
Cl17	0.958	0.958	0
Cl14	1	1	0
Cl11	0.748	0.748	0
Cl10	0.869	0.869	0
Cl8	0.905	0.905	0
Cl3	0.798	0.798	0
Cl2	0.779	0.779	0
Cl1	0.906	0.906	0
Cu8	0.817	0	0.817
Cu7	0.826	0	0.826
Cu6	1	0	1
Cu3	0.828	0	0.828

The total effect of items on safety issues, safety climate and safety culture was found as shown in table 23. It was found that the estimated value is more than 0.7 indicating a good model. The model can explain well the safety issues with the endogenous variable. Also, the safety climate and safety culture have a direct effect on the safety issues, having a total effect of one.

Table 24: Model fit indices for the accepted model

Sl No	Acronym	Explication	Accepted fit	Obtained value	Inference
1	CUMIN/DF	chi square/degree of freedom	<=3-Excellent fit & <=5 Acceptable fit	3.89	Acceptable
2	AGFI	Adjusted Goodness of fit	0.63 TO 0.97, Good fit	0.66	Good fit
3	NFI	Normed fit index	0.72 TO 0.99, Good fit	0.762	Good fit

4	RMSEA	Root mean square mean approximation	0.00 TO 0.13, Good fit	0.1	Good fit
5	PGFI	Parsimony Goodness of fit	>0.5, Good fit	0.621	Good fit
6	PNFI	Parsimony normed fit index	>0.5, Good fit	0.72	Good fit
7	RMSR	Root mean square residual	0.01 to 0.14, Good fit	0.048	Good fit

To accept the model, the model should have standard model fit indices as given in Table 8. The model fit indices of the model under study are shown in table 24. It is clear from the table that CUMIN/DF (comparison if the observed variables and expected results are statistically significant) value is 3.89 which is between 3 and 5, so acceptable. The adjusted goodness of value or AGFI indicates the computation of GFI by adjusting against the degree of freedom and the acceptable value is between 0.63 and 0.97 for a good model. Here obtained value is 0.66 indicating a good fit model. The normed fit index (NFI) indicates scaling between (fitting terribly) independence models and (fitting perfectly) saturated models and for a good model, its value should be between 0.72 and 0.99. Here the obtained value for the model is 0.762 indicating a good fit model. The Root Mean Square Mean Approximation (RMSEA) indicates an overall badness-of-fit measure that is based on the fitted residuals. For a good fit Model, the value of RMSEA should be between 0.00 and 0.13. Here the obtained value of RMSEA for the model is 0.1, which indicates a good model fit. The parsimony goodness of fit index (PGFI) indicates a modified GFI model wherein loss of a degree of freedom is considered. The good fit model has a PGFI value greater than 0.5. In this model considered the value of PGFI is obtained as 0.621 indicating a good fit model. The PNFI (parsimony normed fit index) indicates a modified NFI model wherein loss of a degree of freedom is considered. For a good fit model, the value of PNFI should be greater than 0.5. The value obtained for this model is 0.72 indicating a good fit model. The Root Mean Square Residual (RMSR) value indicates the overall badness-of-fit measure that is based on the fitted residuals. For a good model, the value of RMSR should be between 0.01 and 0.14. For this model, the value of RMSR is obtained as 0.048 which indicates a good fit model. Hence based on the seven indices (Table 24) the model is having good model fit indices. So we can conclude that the model is a good fit model.

5. Conclusion

Safety climate and safety culture have always been root causes of safety issues in the utility sector. Researchers have carried out various studies to determine safety, health and environmental issues in different high-risk industries where the impact of the accident is very high. This study examined the connection of safety climate and safety culture with safety issues. According to this study, safety climate and safety culture have a good correlation with safety issues. Four items are influencing safety culture while twenty-six items are influencing safety climate since they have a high correlation. The exploratory factor analysis showed that the thirty endogenous variables are the root cause of electrical safety issues in the utility sector. The confirmatory factor analysis showed that the two components namely safety climate and safety culture are the influencing factors of electrical safety issues. It was also found that safety climate is influencing more safety issues compared to safety culture in this study. The structural equation model was developed and model fit indices were analyzed to check whether the model is having good fit indices. It was found that indices namely Cumin/df (Chi-square/degree of freedom), Adjusted Goodness of fit, Parsimony Goodness of fit, Normed fit index, Parsimony normed fit index, Root-mean-square mean approximation and Root mean square residual have values of 3.89, 0.66,0.62, 0.762,0.72, 0.1 and 0.048 respectively falls in the good fit model index category. Hence we can conclude that the model is a good fit and the factors namely safety climate and safety culture could explain well the safety issues. The total variance explained value indicates safety climate issue is more compared to the safety culture issue. To reduce the safety issues in the utility sector based on this study, we have to focus more on safety climate compared to safety culture.

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