Perception of Labour's About Safety Climate of Residential Building Projects in Western Mumbai Region

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Abstract- *In Indian construction industry, safety management and practices emerged as important topic due to the diverse culture. The safety climate gives an outlook of basic safety culture's feature. The study aims to investigate the safety climate information in construction projects in Western Mumbai region and find out the specific factors affecting perception of safety climate from four different facets. A questionnaire survey was conducted on six different sites and total of 204 valid questionnaires were collected from this survey. The study reveals that, how age, gender, domicile, employment mode, job experience, etc. affect the labour's perception from four different facets (OSR, SSR, CSR and WSR). A logistic regression analysis gives the correlation of such factors with multifaceted safety climate perception. In this case, local workers tend to have more positive perception of safety climate than workers from outside Mumbai and workers employed directly from organization have positive perception than workers employed by subcontractor. The study also gives the extent of correlation of various factors by giving model under each facet. The findings identify the crucial factors affecting safety climate which helps the safety engineers and supervisor to create a positive safety culture in Western Mumbai region.*

Keywords- Multifaceted safety climate, logistic regression analysis, dichotomous variables, OSR- Organizational Safety Response, SSR- Supervisors Safety Response, CSR- Coworkers Safety Response, WSR- Workers Safety Response, RStudio, Likert Scale.

I. INTRODUCTION

Being a second largest economy in the world, construction industry plays a vital role in the economic growth of developing countries. Indian construction industry with diverse nature due to its diverse cultural background emerges as one of the complex and complicated industry in which construction hazards is the matter of concern. Indian construction industry is considered as one of the most dangerous industries in the world because of its unusual production process, complicated site conditions, non-standard workers behaviour, and subcontracting system. From the past study, it is cleared that, construction hazard directly affect the productivity and quality of work get decreased due to change in the perspective. Various hazards lead to the change in attitude of workers and avoidance work on construction sites, though there is great demand of labours. In India every construction organization focuses on safety and follows safety policies. But it is seen that, importance of such safety rules and policies is limited up to planning phase. When the time comes to execute the project, such safety polices loose its importance. Because, during execution phase, main focus is on to complete the various activities within scheduled time period, which overrule the safety practices.

Inspite of having great safety rules and policies, in many cases, Organization fails to detect the reason behind hazards on site. Now it is important to know, where such safety practices get lagged in order to prevent the accidents and construction hazards on site. Safety education and training plays a crucial role in preventing the hazards. But literature revealed that, such training program works from the Organization end and seriousness among the workers to follow the safety rule is neglected. It is important to focus on labour's perception of safety climate, so that preventive measures can be suggested. Zohar (1980), defines the safety climate as "unified set of cognitions regarding the safety aspects of the Organization". Safety climate is often termed as a predictor of safety behaviour". Apart from this predictive function, safety climate also has the following additional functions: 1) diagnose problem and focus efforts on improving precise sections, 2) determine the Organizations safety performance at departmental level, 3) consume few resources, such as budget and time and 4) involve employees by encouraging them to convey forward their actual feelings. In order to make the site environment safer to work on, it is important to know what labours think about safety climate to enable the organization to improve its safety performance.

Study shows that, labour's perception of safety climate changes with four different facets. Facets are nothing but the response given at departmental level about safety climate such as Organizational safety response (OSR), Supervisor safety response (SSR), Co-workers safety response (CSR) and workers safety response (WSR). So, it is necessary to know the workers perspective under each facet. Logistic Regression analysis plays important role in determining relationship between different factors and each facet.

II. OBJECTIVES OF REASEARCH

Following are the objectives of the study:

1. To investigate and find the factors affecting labour's perception about traditional/current safety climate in Western Mumbai region.
2. To find out the relationship between such factors in terms of correlation matrix. So that the factor which is most considerable can be taken into account.
3. To give the theoretical base to the findings of the study by logistic regression analysis and to support the perceptions with analytical method.
4. To validate the research peer survey to be conduct by RStudio free online statistical tool.
5. To have better safety culture and safety practices to be built according to the labour's perspective to enhance their safety attitude in more positive manner.

III. METHODOLOGY OF STUDY

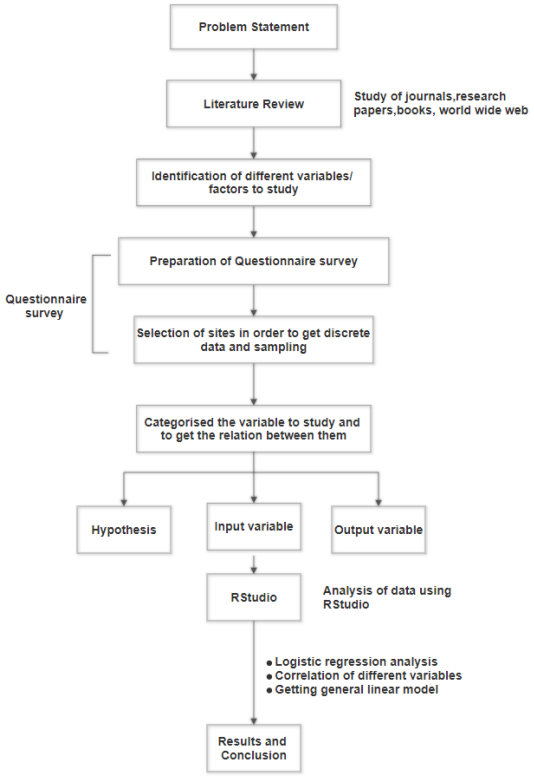

Fig. 1 Flowchart of Methodology

IV. THEOROTICAL CONTENT

Logistic regression is a statistical tool for analyzing a dataset in which there are one or more independent and dependent variables that determine an outcome in terms of correlation. The outcome is measured with a dichotomous variable (in which there are only two possible outcomes). Like regression analysis, the logistic regression is a predictive analysis which shows the effect of one variable on another. Logistic regression is used to describe data and to explain the relationship between one dependent binary variable and one or more nominal, ordinal, interval or ratio-level independent variables.

For example the model gives the responses such as 1 or 0/ Good or Bad/ Agree or Disagree.

Important step of the logistic regression analysis is the task estimating the *log odds* of an event. Mathematically, logistic regression estimates a multiple linear regression function defined as:

$$\text{Log odd} = \log (P/(1-P)) = \beta_0+\beta_1x_1+\beta_2x_2+\beta_3x_3+\ldots..+\beta_nx_n$$

Where, if P is no. of success, then (1-P) is no. of failure

The regression analysis model always gives the values in terms of estimates/log odds which shows the direct relationship between different independent variables and gives the correlation among the different categorical variables falling under single independent variables.

Dichotomous Variable

It is nothing but the nominal variable which has only two categories or level. For marital status, expected answers are categorized into two: married and unmarried. In this study the dependent variables are measured using five point L*ikert Scale* initially. Therefore, they are changed into new dichotomous variables by subtracting their respective.

Variables

OSR, SSR, CSR and WSR are considered as dependent variables. Each dependent variable is nothing but the response which have been weighted and noted down under five point *likert* scale which shows: 1- Very poor, 2- Poor, 3- Good, 4- Very Good, 5- Excellent. The factors such as age, marital status, gender, education level, job experience, drinking and smoking habits, responsibility on worker are considered as independent variables. Whereas, domicile and employment mode are the study variables (control variables). All independent and control variables are divided under different categorical and nominal variable.

As everyone knows, age of person reflects on his perception. Sometimes we refer it as generation gap. Hence, age is categorized in three: 20 or below, 21 to 40 and above 40. Marital status of a worker is categorized to give binary results single (0) and married (1)

Gender is categorized as male (0) and female (1). Education level and job experience are categorized as numerical variable. As Drinking and smoking habits cannot be categorized in numerical variable, there are three categories- No, Not at Work and Even at Work. Responsibility on worker in terms of family members it is categorized in three- 1 to 3(including himself), 4 to 6 and above 6. Domicile is categorized in three groups- Native in Mumbai, Outside Mumbai/Maharashtra and Living in Mumbai from the last 15 years. One of the major points to consider is Language barrier which changes with the states. Employment mode is categorized in three groups- Directly from Organization, From Sub-contractor and Self Recruited on site.

Hypothesis Development

In this study there are four hypothesis made, at the level of 5% significance. If $p|z|>0.05$ then the null hypothesis is true and it is accepted as it. But if not, then model gives significant values which show the relation between different independent variables with the single dependent variable under study.

Following are the null hypothesis made initially to give the basis for reasoning:

a) For OSR, there is no relation between dependent variable (OSR) and independent variables. And it may vary with domicile and employment mode.
b) For SSR, there is no relation between dependent variable (SSR) and independent variable. And it greatly varies with the control variables domicile and employment mode.
c) For CSR, again there is no relation between dependent variable (CSR) and independent variable. And it greatly varies and domicile and employment mode.
d) For WSR, there is no relation between dependent variable (WSR) and independent variables.

V. DATA COLLECTION

On the basis of Literature survey carried out, various factors to study are pointed out which affects the perception of workers in Western Mumbai Region. Those factors are categorized and termed as dependent, independent and control variables, after the discussion with safety personnel in the region. The format for Questionnaire is prepared on which includes the various categorical as well as numerical variables as stated above.

Total *Six* Sites are selected under random sampling in Western Mumbai Region. Each site has been visited for twice to make sure the perceptions are correct for a specific time period. A total of 240 questionnaires were distributed among the workers on the above stated sites, 227 completed questionnaires were returned for a response rate of 94.6 %. After rejecting the extreme and missing values, 204 questionnaires were used for the analysis.

VI. DATA ANALYSIS

From the collected questionnaire survey it is found that, Overall, approximately 43.2 % of the participants are basically from Mumbai, while 44.64 % of the participants are from outside Mumbai/Maharashtra and others are living in Mumbai from the last 15 years. About 58.77% of the participants were employed by sub-contractors, while 29.53%

were directly employed by organization. Approximately, 81.6% of the participants were male and 66.4 % were married. The largest group among participants in terms of age was individuals from 21 to 40 years old (69.5%), while the most common number of family members supported was 4 to 6 (58.29%). Most of participants had the education 10^{th} to 12^{th} Standard. As far as experience considered, it varies and shows the direct relationship with age of the participant. Approximately, 60.14% participants don't smoke or drink at work, while 15.56% participants drink or smoke at work, which indicates negative safety attitude.

Table 1 Descriptive Statistics for Multifaceted Safety Climate

Perception of Multifaceted Safety Climate	Mean	Median	Std. Deviation	No. of Responses
Perception of OSR	4.09	4	0.356	204
Perception of SSR	2.39	2	0.486	204
Perception of CSR	3.43	3	0.379	204
Perception of WSR	4.13	4	0.523	204

Table 1 shows the descriptive statistics for labour's perceptions of the multifaceted safety climate in Western Mumbai Region. The mean and standard deviation of perceptions of OSR are 4.09 and 0.356 respectively. While the mean for SSR, CSR and WSR are 2.39, 3.43 and 4.13 respectively. Hence, the perceptions of OSR and WSR falls between very good to excellent, whereas perception of SSR is between poor to good (neutral) and for CSR, it is good to very good. Among the four dependent variables WSR has a highest mean and SSR has lowest mean.

Analysis with Rstudio

RStudio is the free and open source data analysis software which is widely available. It serves as a foundation for innovative and important work in science and education industry. About 55% of Data Science Analysis is done by using this statistical programming language, which gives the quick and accurate results saving time and laborious work. All the statistical data can be analyzed by RStudio such as showing relationship between one or more dependent and independent variables, regression and correlation matrix, numerical methods, etc.

As per the need and no. of variables to be studied, the coding is done specially to categorize the variables and the software gives the result in tabular as well as in graphical form. Fig. 2 shows the image of first page of RStudio. Red section is for writing the code termed as *R-Script* Section, where green section shows that whether the code is running or not and gives the result in tabular form. Black marked section is to show the data sheets saved.

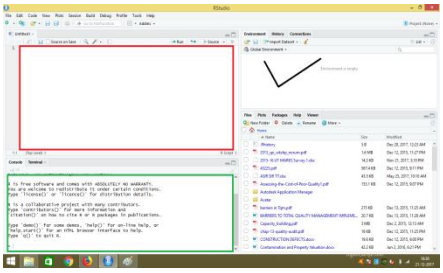

Fig. 2 Image of First page of RStudio

Initially, in order to get the results, some input and output variables were categorized from dependent, independent and control variables. All the independent and control variables were categorized as *Input* and all the dependent variables such as OSR, SSR, CSR and WSR categorized as *Output.* To get the relationship between the input variables and output variables by using logistic regression analysis, RStudio is used as statistical online tool. To find out relationship between various/factors, code is written to give output of Logistic Regression Analysis in RStudio under R-script section.

The data which is to be analyzed is entered in the excel sheet under different heads and this excel sheet is then directly linked with the R-Script section by giving the command. By giving the command to read the excel sheet, the code get direct access to read the different categorical and numerical variables. After reading the variables, RStudio automatically differentiate between the input and output variables and assign the values to each variable as 1 and 0 or 1, 2 and 3. For example, input variable Gender has two categories: male and female, 1 for male and 0 for female. Similarly, Age is categorized in three: 20 or below (1), 21 to 40(2) and above 40(3).

In case of output variables, weighted values of variables are converted into dichotomous variables as 1 and 0 and these values are further termed as OSR dichotomous viz. *OSRD, SSRD, CSRD* and *WSRD.* Now, in order to get the correct relation, it is important to read the values to their numeric form to know extent of correlation and to get correlation matrix. Command is given first covert categorical values to some numeric values and then to form *Spearman Rho Coefficient* matrix (correlation matrix).

Once the correlation between the established, the command is given to find out the VIF (Variation Inflation Factor) for each variable, which explains the variance among different variables. Finally, the command for general linear modeling is given and by using previous stored data of

correlation, model gives the results under each head of dependent variables separately. Each model shows the correlation between different independent variables and each dependent variable.

VII. RESULTS

A logistic regression model was developed consisting of 4 different facets and 9 independent and control study variables. This model was used as a basis to find out the correlation between different variables and each facet where relative importance of each variable in the hierarchy is determined. Experts have been asked to make pair-wise comparisons between two factors at a time, decide which factor is more effective towards workers perception of safety climate, and then specify the degree of correlation. The score for each facet were also collected on 1-5 scale as shown in data collection sheet. The total 204 no. of questionnaire were completed by construction workers and following results are obtained.

Correlation Matrix

All the values lies between +1 to -1. There is a strong correation and linearity between age and job experience which shows as age increases job experience is also increases, which is logically true statement. Age of the person is considered as seaperate variable, to check its correlation with job experience. Once the correlation was established, variables were checked for its VIF by the model. If VIF> 5, that means feature is clearly being explained by the linear comibination of other independent variable. To show the dependency of variables to one another, it is important to make the VIF of each variable below 5. It was found that, VIF of variable Age was 18.0299 which is much greater than 5. As it was the dummy variable and already categorised as age factor and it was introduced to check the correlation matrix, later it was ommited by giving the command and new VIFs of all other variables were generated by the model.

After achieving the linear dependency of each variable, seperate models were formed for each dependent variable i.e OSR, SSR, CSR and WSR, which showed the relation each facet with other independent variable i.e gender, marital status, age, job experience, education, drinking and smoking habit, respossibility on worker (in terms of family member), domicile, employement mode.

As each facet is correlated with study variables (independent and control variables), model gives the value at 0.05 (5 %) significance level. If p>0.05, then null hypothesis made is considered as true.

Table 2. Model of OSR on Study Variables

	Estimate	Std. Error	z value	p>|z|
Gender (0)	-1.997	1.546	0	1
M.S. (0)	9.091	1.81	0	1
Education	1.46	1.06	0	1
Job Exp.	-1.603	2.592	0	1
Age Factor (2)	-9.562	2.736	0	1
Age Factor (3)	2.668	3.1	0	1
D.S. Habit (2)	3.93	1.637	0	1
D.S. Habit (3)	-1.301	2.884	0	1
R of W. No. of F (2)	4.477	1.636	0	1
R of W. No. of F (3)	1.545	4.064	0	1
Domicile (2)	1.119	1.453	0	1
Domicile (3)	6.88	2.191	0	1
Employment mode (2)	-2.115	2.247	0	1
Employment mode (3)	1.918	1.479	0	1

From the table 2, it is cleared that, workers perception on OSR are not at all dependent on their age, marital status, job experience, etc. proving that hypothesis (a) is true. But in case of domicile and employment mode, it varies. When compared log odds values i.e estimate, it get cleared that, if the are workers from outside Mumbai/Maharashtra, then the log odds of OSR being good is increased by 1.119 times as compared to local workers. Similarly, if the workers which are employed by sub-contractors, then the log odds of OSR being good is reduced by 2.115 times as compared to workers which are employed directly by organization.

Similarly the model under each facets i.e SSR, CSR and WSR are developed and the results are compared based on the values of log odds estimated.

Overview of Findings

From the analysis of questionnaires and interviews of labours conducted on site, following findings are overviewed which affected on perceptions directly or indirected:

Regarding the labour's perception of multifaceted safety climate, the mean scores are 4.09, 2.39,3.43 and 4.13 from five-point Likert scale for the perceptions of OSR, SSR, CSR and WSR, respectively. Perception for OSR and WSR are good and Perception for SSR is nearly poor, whereas perception for CSR is in between good to very good.

Being a construction organisation, every company is serious about its reputation in the construction market. Irrespctive to the labour's perception, organisations try to incorporate the safety rules on sites and always look for better safety practices. Research showed that, on all the six sites in Western Mumbai region, organisations conduct safety training and education programs, provide PPE and hire safety engineers. But they are lagged in taking actions in emergency situations. Also organisations show less interest in workers perception of safety climate. It is assumed for them all the workers are following the safety rules. In the case of Supervisor's behavior, it is found that, SSRs are poor. Because, in order to meet the deadline, almost all the supevisors avoid the safety practices as they are less cocerned about safety. Also from the analysis it is cleared that, supervisors are biased in terms of domicile and employement mode. In case of Co-worker's behavior, there is communcation gap in terms of education level, domicile and employment mode in different categories, which resulted in groupism and leads to give negative feedback for co-workers. In case of Worker's behavior, every worker uses PPE and attends safety training program and more or less is aware about the nature of site. So, WSR was almost good. Only it lagged in safety attitude. The worker who drinks/smokes even at site, with less job experience and education, and from outside Mumbai/Maharashtra tends to have negative safety attitude.

VII. CONCLUSIONS

From this study, the logistic regression model gives the theoretical base to all the perceptions of workers about traditional safety practices in multifaceted manner and the conclusions are made as discussed below.

- The effectiveness of safety management on construction sites in Western Mumbai region may be reduced by the complexities and conflicts of participants from various background and cultures. Being a diverse region, the attitude towards safety of workers from the same group seen to be changed, considering all the socio-economic as well as psychological factors.
- The objective of the research was to investigate safety climate information in national context, and to identify the different specific factors that are important to safety climate in various local construction projects. The logistic regression analysis results indicate that domicile and employment mode can partly affect perceptions of safety climate from four facets such as OSR, SSR, CSR and WSR. In which, CSR and CSR has higher significance as compared to OSR and WSR.

Table 3. Significance of Safety Responses

Factors	SIGNIFICANCE ON MULTIFACETED SAFETY			
	OSR	SSR	CSR	WSR
Gender	No	Yes	Yes	No
Marital status	No	No	No	No
Education level	No	Yes	Yes	Yes
Age	No	Yes	Yes	Yes
Job experience	No	Yes	No	Yes
Responsibility on worker	No	No	No	No
Drinking/smoking habit	No	Yes	Yes	No
Domicile	No	Yes	Yes	No
Employment mode	No	Yes	Yes	No

- Local workers tend to have more positive perceptions of safety climate than their co-workers from outside Mumbai/Maharashtra.
- Workers employed directly by organization tend to have more positive perceptions of safety climate than those employed by sub-contractor. To validate this, 11 industrial personnel and 4 safety engineers were interviewed to discuss the relationship between study variables and safety climate, and how the findings of this research may effectively help to improve safety culture in Mumbai.
- The findings of this research provide some practical implications. As SSR was low, project manager should pay more attention to safety management and should focus on the factors that influence safety practices. Such as drinking/smoking on site, co-ordinate the workers, etc.
- This research does not mean to suggest that the labors of different domicile should be discriminated. On the contrary, all the labors have equal opportunity to enhance their safety knowledge. Safety engineers and project manager should adopt diverse safety management practices to improve the perceptions of workers from outside Mumbai/Maharashtra. For example, the safety training program should be conducted in various local languages like *Bhojpuri*, *Bengali* and use of videos, posters during the safety training program will help to increase the interest of labors as most of the workers are from Bihar, Orisa and West Bengol.
- To gain positive SSR, supervisors involvement should be increased in safety related programs. Before recruitment of supervisor, organization should commit to the value safety first, than production.
- To increase the awareness among workers employed by subcontractor, management should focus on

subcontracting with trusted people for hiring the labors from age group 25 to 35, with moderate job experience and from familiar cultural background.

- The findings of the study highlight on the importance of national, organizational, and individual factors like age, gender, etc. affecting safety management in construction industry in Mumbai and provide strategies to create more positive safety climate.
- In Mumbai, accommodation for workers from outside Mumbai/Maharashtra is an issue. Provision of temporary labor camp help to create positivity among workers. It is found that, SSR and CSR by female workers were negative. So, special care must be taken to treat them with respect by others in the organization.
- Workers with the age group below 20, should be given minimum responsibility, to get familiar with other works and awareness.
- In case of SSR and CSR, education level has negative impact. This statement is contrary, but later it came to know that, a labours with higher education level were more positive towards CSR and WSR, which shows the awareness of safety rules and policies.

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