

# Safety Perception Survey as a Tool for Improving the Safety Climate in a Manufacturing Industry

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**Abstract-**Safety in the Steel industry has always been an area of concern. Though significant improvements in safety awareness of the employees have been achieved along with deployment of safer equipment & technology, incidents still continue to occur and the industry still continues to lag behind most other high risk industries as far as level of safety climate is concerned. A safety climate survey aims to measure employee's perceptions on the status of safety at their workplace & can help in identifying the gaps in various Safety Management System elements, thereby providing management with useful insights to plan their strategies. The paper aims to measure the Safety Climate of a Steel manufacturing Plant through a Safety perception survey. A questionnaire-based survey was considered as it is one of the most frequently used and widely accepted methods for measuring safety climate. A questionnaire was developed consisting of 5 safety climate components with 44 questions and was administered to 102 employees (Supervisors, technicians, workers, etc.). Various Statistical tools like mean, SD, Variance, Cronbach's alpha & Split half correlation, and one-way ANOVA test were applied for doing various types of analysis and arriving at conclusion.

**Keywords-** Safety culture, safety climate, perception.

## I. INTRODUCTION

Despite substantial efforts to ensure safer operations, occupational accidents continue to occur in industries & the safety scenario continues to be far from satisfactory. Based on ILO estimates, 2.3 million workers die every year from work-related injuries and diseases.

An additional 160 million workers suffer from non-fatal work-related diseases and 313 million from non-fatal injuries per year. The ILO estimates that more than 4 per cent of the world's annual GDP is lost as a consequence of work-related injuries and diseases. An important factor in the chain of events that lead to various safety mishaps is employee at-risk behaviour. The most important factor which influences the human behavior at work amongst others is poor safety culture.

The steel industry worldwide has been regarded as a Hazardous Process Industry As per World Steel Association; there is no area, process, or type of work that cannot be accident-free. Safety and health require a permanent 100% commitment from everyone. Though several initiatives like awareness, monitoring, audits, training, compliance reviews, etc are being conducted & the accident frequency rates have improved over a while, but the safety performance has got stagnated. To improve from this level, safety needs to be managed from a behavioral/cultural perspective. Most importantly, it

requires a strong commitment from top management and all levels of management, which should set the culture in which safety and health are the number one priority and must not be compromised for any other objective.

High risk industries such as the offshore oil companies, chemical industries, nuclear reprocessing plants etc. have successfully demonstrated that creating and maintaining a positive climate for safety is vital for achieving sustainable change in the safety scenario. The safety climate of an organization represents the overall mental framework that workers' have about how safety is treated during the day-to-day activities in their organization. Since safety climate is a snapshot of safety at one point in time, it can change quickly, on a daily or weekly basis.

For example, an incident or the implementation of a new safety process may heighten the safety climate. If the safety climate is consistently positive over multiple points in time, it will inevitably have an impact on safety culture because positive behaviors and attitudes will be reinforced. Similarly, if the safety culture is strong, the safety climate will reflect it through the positive feedback received from surveys. Thus, Safety culture and safety climate are mutually formative, meaning they impact each other. To summarize, safety culture is the commitment to safety by all, and safety climate is the perception of that commitment to safety. The best way to measure safety climate is through surveys which provide a quick snapshot

of the company's safety program from the perspective of workers. It helps organizations in evaluating their safety program, establish priorities, motivate improvement and monitor performance.

## II. REVIEW OF LITERATURE

Research on the perception of workplace safety began in the early 1980s and has since received considerable attention in organizational and psychological literature. Reference [18] used a 40- item questionnaire to measure organizational safety climate for 20 industrial organizations in Israel.

Reference [2] identified factors that positively contribute to injury reduction in the railroad industry as well as in several other industries by using the Minnesota Safety Perception survey tool.

### **Relation between Safety perception, Safety behaviors, and Safety outcomes:**

Perceptions, like attitudes, have been recognized as an important factor in safety. Research in this area suggests that when measured, perceptions can predict the likelihood of certain behaviors. Reference [10] revealed that poor perception of risk is closely linked with unsafe driving behavior & crash amongst young drivers. The importance of perception is especially critical where employees have little or no direct supervision.

In such settings, an employee makes important choices and decisions about safety rules, practices, and procedures. If perceptions about safety are low, that employee may be more likely to take a shortcut or engage in some other at-risk behavior that can lead to an injury.

Reference [1] showed that in plants that had low injury rates, the employees' perception of management commitment to safety was highly positive. On the other hand, in plants where injury rates were high, the employees' perception of management commitment to safety was low and the major focus of management's safety efforts was on OSHA compliance with limited employee involvement practices. Reference ([2], [3], [14], [15]) had also supported the above findings.

Reference [9] noted that workers' perceptions of high workload and work pressure tend to be associated with an increased tendency to engage in unsafe acts which in turn increases their susceptibility to accidents. Reference [8] concluded that employees, who perceive their jobs as safe, tend to be involved in fewer accidents than employees who perceive their jobs as relatively more dangerous.

Reference [19] found that prioritizing and valuing safety through proper feedback & interaction results in decreased employee injuries & improved safety climate scores.

Reference ([5], [15]) demonstrated a significant link between perceived safety climate, hazards & risks, work pressure, barriers, etc., and safety behaviors among workers.

Reference [6] found statistically significant relationships between safety climate, personal characteristics (like gender, education level, safety knowledge, etc.), and individual safety behavior.

Reference [16] had shown that workers are more inclined to address unsafe working conditions when they perceived the support of their supervisors in encouraging them to do so, and when their coworkers also encourage others in speaking out about safety issues. Reference [11] found that when the workers are convinced of the top management's openness in listening to their safety problems & taking effective control measures, they are more likely to report these problems to their supervisors.

Reference [12] concluded that the employees tend to take shortcuts & deviate from safety norms if they perceive the managers as uninterested & uncommitted to their safety problems. The reverse was also true: the more the managers were perceived as getting actively involved & committed to solving employee's day-to-day safety concerns, the less the latter tended to take risks or violate safety rules.

Also, many studies indicate that workers' backgrounds influenced safety climate. Reference [7] explored the safety climate among employees working at different job locations & job positions in a nuclear decommissioning and demolition industry at 10 locations in the USA. Reference [17] investigated workers' backgrounds and safety climate among 1566 employees belonging to eight major accident hazard process industrial units in Kerala.

Currently, most organizations use some form of a trailing indicator, such as injury incident rates, to measure the success or failure of safety processes and programs. Reference [3] concluded that a safety perception survey can be used as a leading or predictive indicator of the success or failure of safety processes and programs. Reference [13] found that employee perceptions of the safety system are related to management's commitment to safety, which, in turn, appear to be related to injury rates and as such, can serve as a tool to help an organization continuously improve SH&E efforts.

## III. PURPOSES AND HYPOTHESES:

The purpose of this research is twofold i.e. to explore Steel Plant's safety climate and also to identify workers' background influence on the safety climate. As a result, the author formulated the following hypotheses based on the literature studies:

- **Hypothesis 1:** There is a significant difference in the safety-climate perception among workers of different qualifications.
- **Hypothesis 2:** There is a significant difference in the safety-climate perception among workers of different job experiences.

#### IV. MATERIALS AND METHODS

##### 1. Questionnaire:

A questionnaire (survey tool) was prepared to comprise 44 questions distributed under five safety-climate factors:

Table 1. Climate Factors.

S. N.	Safety climate Factors (SCF)	No. of questions
1	Safety Leadership&Commitment	08
2	Safetyattitudes& beliefs	13
3	SafetyCommunication& Training	06
4	Safetyprocedures, rules& guidelines	12
5	Motivation/Recognition/involvement/Empowerment	05

At the time of distribution, questions were intermixed & circulated without being grouped under any of Safety Climate Factor (SCF). A five-point Likert scale was used to capture the safety-climate variables in the questionnaire, ranging from 1 as 'strongly disagree' to 5 as 'strongly agree'. An average score that is higher than 3 is considered as a positive or good safety climate.

##### 2. Participants Demographics:

The assessed Steel Company is producing stainless steel in the form of coils & sheets used for the industrial sector. The company employs 859 employees as of 01-06-2021. A total of 102 workers voluntarily participated in the survey of this study.

Reference [4] shows that for most basic surveys, a target of 100 or 150 responses should provide sufficient statistical power to detect any effects that are present. The workers' backgrounds consist of workers' age, qualification, designation & job experience. The breakup of survey participants in terms of the above background attributes is shown below.

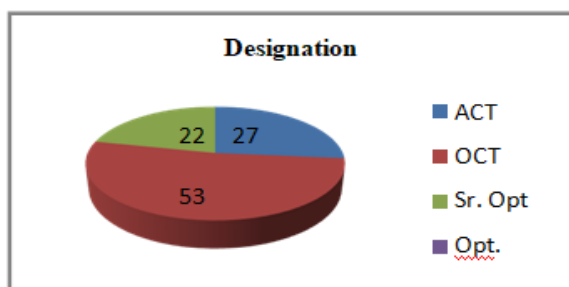


Fig 1. Numbers of respondents with different designations

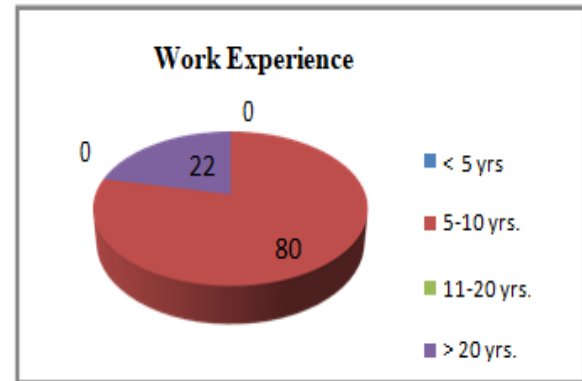


Fig 2. Numbers of respondents with different work experience

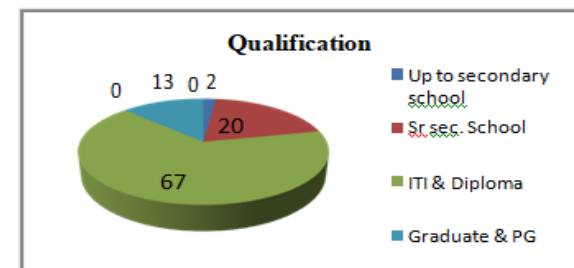


Fig 3. Numbers of respondents with different qualifications

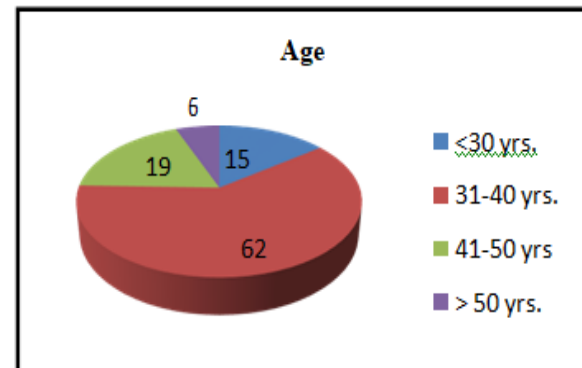


Fig 4. Numbers of respondents with different age group

##### 3. Statistical Tools & Analysis:

**Validity & Reliability:** Validity and reliability are two key factors to consider when developing and testing any survey instrument. For Validity, the questionnaire has been prepared by the author after extensive literature review and subsequent discussions with corporate safety heads, safety managers of the organization and their suggestions were incorporated.

For testing reliability, one of the approaches suggested to the questionnaire, is to divide the test into even and odd questions and compare (correlating) the participant's scores on two halves of the test. This test known as the Split-half reliability test was conducted and the resulting correlation was then adjusted for test length using the

Spearman- Brown prophecy formula. Also, to measure the reliability of the questionnaire, Cronbach's Alpha ( $\alpha$ ) value was computed along with the Split half reliability test.

The safety-climate scores were obtained by calculating the mean value for each safety- climate factor included in the questionnaire. To identify the influence of workers' background on safety climate, a one-way analysis of variance (one-way ANOVA) was used in this study.

## V. RESULTS

### 1. Reliability Test:

The combined Cronbach's alpha for all elements / factors of safety climate was calculated to be 0.6447 (near to 0.7, the suggested threshold value). The reliability correlation by a Split half methodology was calculated as 0.5818 and the Spearman- brown correction was 0.7356.

### 2. Safety climate level of the proposed model:

Table 2. Mean score analysis of Safety Climate Factors.

Safety climate factor(SCF)	Items/questions	Mean(N=102)	Factor mean	Grand mean
SCF-1: Safety Leadership & Commitment	Management doesn't encourage open & frank discussion on safety issues	3.17	3.27	3.66
	Production is usually seen as more important than safety by management	2.19		
	Management does not appreciate if we report any hazards at the workplace	4.75		
	Our HOD seldom holds periodic meeting with sr. officials & employees on safety issues	2.36		
	Any new idea or suggestion to improve safety is seldom acted upon	3.20		
	Accident investigation is usually done to identify who is to blame	3.29		
	Management acts only after any accident has happened.	3.44		
	Management does not allocate sufficient resources to health & safety	3.83		

SCF-2: Safety Attitudes & Beliefs	Safety is the job of safety department or my supervisors and not my problem	4.63	3.87	
	Accidents cannot be prevented by any means	3.		
	Safety posters, caution boards, publications etc. has little influence on the awareness and behavior of people.	2.54		
	Minor incidents without any injury (near-miss cases) need not be reported to anyone as it will be taken otherwise	4.64		
	Safety rules/procedures slow down the progress of work	4.13		
	People are just unlucky to suffer an accident	3.		
	I work safely only due to the fear of being watched by my supervisor	4.27		
	There is nothing I can do to further improve safety here	4.12		
	Safety & health meetings are a waste of time as nothing substantial comes out	4.12		
	I feel that safety issues are not the most important aspect of my job	3.91		
	Operational targets often confront with safety measures/procedures	2.13		
	I can talk to my supervisor anytime about safety issues	4.16		
	I always get the Personal Protective & other equipment, required to do the job safely	4.09		
SCF-3: Safety Communication & Training	My supervisors often remind workers of the potential risks & hazards at the workplace	4.04	3.66	
	Safety training is not compromised in favor of other issues like production etc	3.44		

	Employees are given sufficient information about safety incidents that occur in our plant/other Plants/ Units	3.32		
	Safety talk imparted to us is very useful with job-specific inputs	4.11		
	I receive training when new procedure & equipment are introduced	3.38		
SCF-4: Safety Rules/ Procedures/ Guidelines	As long as daily targets are achieved, my supervisors do not care whether we work according to safety rules or not	3.87	3.80	
	Taking short cut to get work done quickly is not accepted by my work crew	3.92		
	We perform jobs based on our knowledge & experience as no procedure are available	3.74		
	Machine, equipment & facilities are poorly maintained and not safe to work	3.57		
	Safety devices, interlocks etc. are never bypassed for sake of production and if required they are bypassed with proper documentation & restored in timely	3.99		
	Supervisors conduct safety inspections of shop floor areas occasionally and no improvement is noticeable	3.24		
	I fully understand safety rules and risks associated with my job	4.25		
	Some of the safety rules & procedures are not practical	3.84		
	Sometimes, it is necessary to depart from safety requirements for production sake	3.69		
	The written safety rules & instructions are easy to understand & implement	4.19		

	Sometimes work conditions in the deptt. hinder my ability to work safely	3.44		
	My workmates would react strongly against the people who break safety rules/procedures/instructions	3.81		
SCF 5: Motivation/ Recognition/ Involvement/ Empowerment	My supervisor consults for the suggestion about how to improve safety	3.75	3.70	
	Safety minded persons are encouraged/ recognized by my supervisors	3.82		
	We are consulted while reviewing safety rules/ operating procedures	3.28		
	We are empowered to stop work and report to the supervisor if it is unsafe	4.24		
	Introduction of awards & incentive schemes will help in improving safety	3.15		
	Co-workers give tips to each other on how to work safely	3.85		
Scale denotation: Likert scale: 1= Strongly disagree to 5= Strongly agree				

### 3. Identifying Workers' Background Influence on Safety Climate:

The two proposed hypotheses were tested by using one-way ANOVA to investigate the relationship of workers' background towards safety climate.

#### 3.1 Worker's job experience & safety climate:

Table 3. Experience vs. Safety climate.

SCF	Mean		Standard Deviation		One Way Anova		Remarks [Significant (S)/NonSignificant(NS)]
	Group-I (Exp-less than 20yrs. (N=80))	Group-II (Exp 20yrs. & more) (N=22)	Group-I (Exp-less than 20yrs.) (N=80)	Group-II (Exp 20yrs. & more) (N=22)	F Stat	p-value	



SCF-1	SCF-2	SCF-3	SCF-4	SCF-5
2.8525	3.3233	3.0233	3.1533	3.1650
3.24	3.7933	3.8383	3.6440	3.7950
0.3647	0.5386	0.32	0.2982	0.2182
0.4694	0.5885	0.3116	0.4057	0.3011
3.3997	4.1652	19.9772	10.6801	17.2225
0.0865	0.0534	0.0012	0.0038	0.0020
P>0.05, NS	P>0.05, NS	P>0.05, NS	P>0.05, NS	P>0.05, NS

### 3.2 Worker's Qualification & safety climate:

Table 4. Qualification vs. Safety climate.

SCF	Mean		Standard Deviation		One Way Anova		Remarks [Significant (S)/Non Significant (NS)]
	Group-I (ITI & Diploma) (N=65)	Group-II (Others-Sec. school, Sr. secondary school, Graduation & PG) (N=37)	Group-I (ITI & Diploma) (N=65)	Group-II (Others-Sec. school, Sr. secondary school, Graduation & PG) (N=37)	F Stat	p-value	
SCF-1	3.3525	3.4213	0.4327	0.5420	0.0787	0.7831	P>0.05, NS
SCF-2	3.8342	3.7192	0.4814	0.4401	0.3730	0.5476	P>0.05, NS
SCF-3	3.6633	3.7467	0.4432	0.2292	0.1674	0.6910	P>0.05, NS
SCF-4	3.7075	3.6883	0.4672	0.3638	0.0126	0.9115	P>0.05, NS

SCF-5	3.7650	3.7783	0.3980	0.1902	0.0787	0.7831	P>0.05, NS
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## VI. DISCUSSION & RECOMMENDATIONS

The obtained values of Cronbach Alpha as well as Spearman-Brown correlation indicate that the survey tool with the 44 questions is internally consistent & reliable and hence, an appropriate mechanism to measure safety climate. However, there is scope for further improvement by adding more questions for getting a further improved level of reliability (e.g. 6 more questions for achieving reliability of 0.9 as per Spearman-Brown formula).

The grand mean score of Safety climate for the entire survey was found to be 3.66 (Table-1) which indicates a good safety climate level (Proactive, Fig.-1) in the industry under study. This was arrived from the safety climate scores of individual climate factors namely SCF :1- Safety leadership & commitment ( $\bar{x}$  = 3.78 ), SCF-2: Safety attitudes & beliefs ( $\bar{x}$  = 3.87 ), SCF-3: Safety communication & Training ( $\bar{x}$  = 3.66 ), SCF-4: Safety rules, procedure & guidelines ( $\bar{x}$  = 3.80 ) and SCF -5: Motivation, involvement & empowerment ( $\bar{x}$  = 3.70 ). As evident, the individual mean scores of different SCFs ranges between  $\bar{x}$  = 3.27 – 3.87 which is an indicator of a good safety climate level, however, it is important to mention here that there is the scope of further improvement in each of the factors under study to achieve an overall score of more than 4 & above (Generative, Fig.-1) by improving employees perceptions.

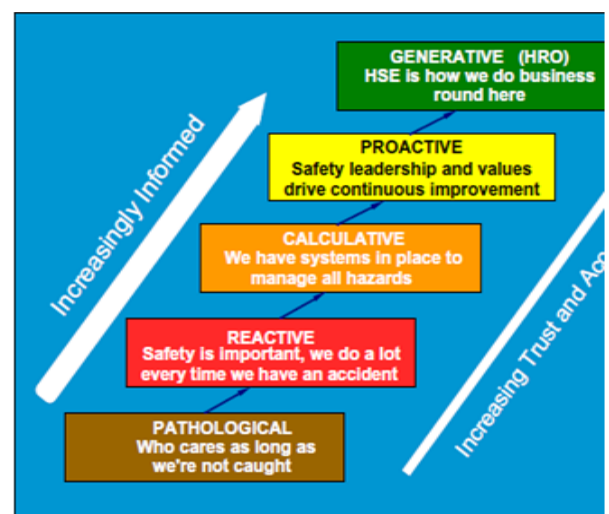


Fig 5. Safety culture maturity ladder.

Special emphasis has to be given on SCF-1: Safety Leadership & commitment, the mean score of which was found to be lowest amongst all the factors ( $\bar{x}$  = 3.27, less than 3.5). Top management visible commitment & felt

leadership is key to the development of a positive safety climate in any organization. Reference [18] shows that a Strong management commitment to safety has been identified as a major influencing factor on safety climate.

The top management has to be as much committed towards safety as for other business functions and safety has to be a core value. The focus has to be shifted from production to safe production and management should pay attention to what could go wrong rather than what has gone wrong.

An effective system of incident investigation has to be put in place only to identify the root cause so that their recurrence can be avoided by taking corrective measures rather than putting blame on individuals which would have a detrimental effect on reporting of incidents including near-miss cases. Employees' suggestions should be recognized & even awarded if they are found to be practical & help in improving the safety environment. More resources should be channeled towards safety to further strengthen health and safety adherence.

The second SCF with the lowest mean score was found to be SCF -3: Safety communication & training ( $\bar{x}$  =3.66). Having competent employees is a requirement for keeping equipment and facilities in "safe" operating conditions. Leadership training with a focus on the behavioral aspects of safety is necessary for creating a safety culture. Proper training upgrades the performance of the individual and teams.

Average training man-days (per person per year) must be sufficient to ensure effective learning and relevant safety skills. Training participation has to be made mandatory and any deviation in this regard to be viewed seriously by senior management. Employees must be made aware of lessons from unfortunate incidents taking place in Plant as well as in the industry to ensure that sufficient measures are in place to prevent recurrence of similar incident and if required, modification in existing safe work procedures can be done.

Employees are to be made aware about the control measures w.r.t new hazards that may be introduced with change in technology, equipment, the introduction of new chemicals etc. Training should focus on hazard identification and risk assessments, which may offer organizations long term benefits, which will potentially lead to a reduction in occupational accidents & injuries.

The means scores of the different questionnaire under SCF-2: Safety attitudes & beliefs range from  $\bar{x}$  = 2.13 to 4.63. The perception of employees regarding the impact of safety posters, displays on their behavior was not satisfactory. It was also found that employees believe that many a time high production pressure result in the slack implementation of safety norms & procedures.

The reason behind these perceptions may be poor maintenance of safety boards & displays, issues regarding their visibility and their generic nature. All such displays are to be in a language understood by the majority of workers, they should be legible (visible from a distance) & the message needs to be job-specific in the form of salient but important Do's & Don'ts. This will result in drawing their attention & improving their awareness. Also, the production pressure needs not be allowed to have a detrimental effect on the implementation of safety norms.

Instead of Production, the importance of safe production is to be highlighted to. Safety has to be inbuilt with the operation process & integrated and need not be considered as an independent silo. The line manager has to be responsible & accountable for safety in their respective domains rather than the safety department & they should be actively involved & committed.

The mean score of various questionnaire under SCF - 4: Safety procedures/ rules/ regulations ranges from  $\bar{x}$  = 3.24 to 4.25. Only 2 questionnaires on perceptions regarding the adequacy of workplace inspections by the supervisors and safe work environment were found to be inadequate. Safety inspections need to be done in a structured manner with a checklist to identify unsafe acts & conditions and deviations, if any, are to be plugged continually so that there are visible improvements at the shop floor.

Delays in compliance to serious deviations of high risk potential (like missing guards, improper working platform, inadequate illumination, electrical/ confined space/ gas related hazards etc.) are to be escalated to next higher level of management in hierarchy for timely normalization. Further, job- specific safety talks to be provided by line managers & Safety officers on the general as well as hidden hazards associated with the job along with emergency measures before start of any job.

The experienced workforce is a great source of strength to any organization in all business domains including safety. They must be involved while making any new safety procedure / changing the old procedure. This will result in greater acceptance and will ensure smooth implementation of safety norms at site. At the same time, good safety performers are to be identified & recognized through suitable means. Award for most safety-conscious worker/ supervisor, for reporting of near-miss cases, for maintain good housekeeping at the shop floor, etc. can be started which will help in motivating all concerned towards safety. All this would help in improving the perception level w.r.t SCF -5: Motivation / involvement/ recognition.

## **1. Influence of Workers' Background on Safety Climate:**

**1.1 Workers' job experience and safety climate:** When workers were categorized in 2 categories i.e. experience less than 20 yrs. and that with 20 & more years, one-way

ANOVA results in Table - 2 ( p- values) show that the workers' perception of SCF# 3,4 & 5 i.e. Safety training & communication, Safety rules /standard/ procedures/ guidelines, and motivation/ recognition /involvement statistically differs between the two categories.

The workers with more experience had better perceptions (mean scores 3.83, 3.64 & 3.79) as compared to those with less work experience (mean scores 3.02, 3.15 & 3.17). This may be due to their long experience/acquaintance with industrial background, more exposure to safety training programs, learning from past failures & better understanding of hazards associated with their jobs.

### 1.2 Workers' qualification and safety climate:

When workers were categorized in 2 categories i.e. one with technical qualification of ITI / Diploma and other with normal school/ college/ university level qualification, one-way ANOVA results in Table- 3 shows that there is no significant difference ( p- values > 0.05) in the perception of workers of two categories about all the five SCFs .

## VII. CONCLUSION

As evident from the above study, there is tremendous scope of improvement in the safety climate of the industry under study and management needs to focus on the highlighted issues/ factors. Though there has been improvement in the safety performance of the steel industry in general, the goal of Accident-free Steel appears to a distant dream. Still occasional non- compliances & bypassing of safety barriers are resulting in serious & fatal injuries.

This calls for Safety culture transformation encompassing a holistic & integrated approach covering elements like leadership commitment & engagement, management of risks associated with highly hazardous processes, capability & competency building of stakeholders, robust standards & procedures, behavior-based interventions, effective monitoring tools like safety audits etc. and most importantly a strong governance structure for overall thrust & direction. These would help the organizations in transforming the safety culture through improvement in safety perception of employees.

This research is a case study and the results are derived from the data of one company, but the methodology of this research may be useful as a model for further research, and the findings may provide useful information for line managers and safety practitioners in the steel industry to improve the safety climate.

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