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Study of Safety Culture in an Oil and Gas Industry and its Correlation with Occupational Stress

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ABSTRACT

The research study had aimed at identifying the correlation of safety culture in an Oil and Gas industry and how it affects the accident rates. The occupational stress factors' role in abetting the safety culture was also one of the objectives of the study. Most of the research study which existed as on date available for public was on correlations study carried out for shipping industry. The oil and gas industry has had similar studies but the data of the same was found to be kept very confidential and not shared out. This research thus aims to bring out in open the culture shift which is required in a company to bring in the necessary changes that are required. Also, the research aims at bringing the intricacies involved in a safety culture change for better understanding of how the culture shift occurs in an organization. The study had used the t-Tests and ANOVA calculation packs which are inbuilt into excel Data Analysis solver pack to get the correlation studies carried out. The scales were standardized to suit the requirement. The reliability and validity of those proven through the Cronbach's alpha being higher than .70.

Key Words : Oil and gas industry, Occupational stress, Safety culture

INTRODUCTION

Organization Culture is a concept often used to describe the assumptions, underlying beliefs, shared corporate values and ways of interaction that accords to the exclusive social and psychological environment of an organization. It is also an underlying factor to various aspects of an organizations functioning such as risk, safety, quality, customer focus, production etc. As such, culture provides a context for action which ties together the distinctive parts of an organizational system in the quest for corporate goals. A strong culture which dominates and permeates the structure and associated systems makes it a successful organization, here nothing is too trivial or too much trouble. Every effort is made by every member to ensure that all activities are done the 'right' way. Thus, the prevailing organizational culture serves as a powerful lever in guiding the behaviour of its members in their everyday work. The more that members repeatedly behave or act in ways that appear to them to be natural, obvious and unquestionable, the more dominant the culture becomes. Although there is a danger that the culture could become static and stagnate, in successful organizations, it tends to be dynamic and take on a life of its own, influencing, and in some cases determining, an organization's ongoing strategies and policies. An organization's culture, therefore, impinges upon and influences most aspects of work activity, affecting both individual and group behaviour at all levels in the workplace (Geller, 2001).

Why Culture Matters? :

Based on the research carried out by the world-famous consultancy firm McKinsey & Company, there are four main reasons for understanding an organization

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in the context of culture:

Influence of culture on the performance:

Based on the research on over thousand organizations, companies coming in the top quartile in terms of culture posted a return to shareholders sixty per cent higher than median companies, and two hundred per cent higher than those in the bottom quartile. This simple fact itself signifies what role culture plays in an organization's success in today's agile business world.

Trademark through culture:

In the current world of advanced technological and digital innovations, every organization faces the persistent threat of its products and business models being replicated. One of the prime decisive leads would be a healthy organization culture that adapts automatically and is versatile to the changing conditions to find new avenues to succeed.

Adaptability enabled by healthy culture:

In the current world where the only thing which is permanent is change, culture becomes even more imperative as organizations with high-performing cultures thrive on change. On the contrary, unhealthy cultures are slow to respond and succumb to change. The research shows that 70 per cent of organization transformations fail, and 70 per cent of those failures are due to culture-related issues.

Under performance or breakdown through an unhealthy culture:

A slow death through an unhealthy culture for many organizations have become the headlines of the daily newspaper and has now been proven over the era, this could be the resultant of a lacklustre performance from an unhealthy culture.

Safety culture:

The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization's health and safety management. Organizations with a positive safety culture are characterized by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures. Unless safety is the dominating characteristic of an organization's culture, which arguably it should be in high-risk industries, safety culture can be viewed as that subcomponent of organizational culture which alludes to individual, job and organizational features affecting and influencing health and safety. The prevailing organizational culture therefore will exert a considerable influence on safety (Cooper, 2003).

Safety Culture and Occupational Stress:

Occupational accidents form a majority of deaths, disabilities and injuries leading to enormous suffering in the affected individual workers and their families. Such accidents prove very costly to employers in terms of direct and indirect costs associated with it. These incidents also cost profoundly to employers. The 2016 Annual Report published by the International Oil and Gas Producers (IOGP) accounted for 2,895,621,000-man hours put in by the member companies, with 50 fatal accidents, 29 Fatal Incidents and a Fatal incident rate of 1.97. Although the number of incidents has decreased slightly by 7.4% the estimated economic loss (direct and indirect) from these incidents have not gone down significantly. Excessive stress has been proven to be a major contributing factor to workplace accidents. Psychological distress has a strong impact on safety outcomes, such as accidents and injuries. Numerous studies have strongly supported the links of workers' safety outcomes with occupational stress and safety behaviours (https://www.ncbi.nlm.nih.gov/pmc/article/PMC5605897/).

Safety Culture, how it influences the workplace:

Safety Culture has been proven through year of research to be a crucial factor in reducing accidents in industrial workplace and improve workplace environment and enhance production. The DuPont Bradley Curve™ is one of the most acknowledged studies, which is being shown below in graphical format (Fig. 1).

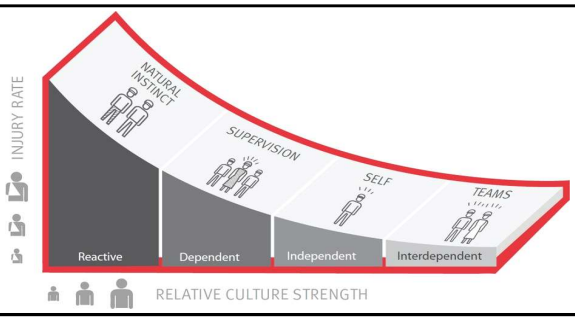

Fig. 1 : The DuPont Bradley Curve

The curve above explains the sequences followed by an organization in its journey towards a mature safety culture (https://www.iogp.org/bookstore/product/safety-performance-indicators-2016-data/#0).

Significance of the study :

The researcher was intrigued by the number of incidents which were happening around workplace and the reason for the same. Identifying the cause to be safety culture deterioration, the researcher has aimed to carry out a survey and analyze data to identify the shift in culture which has happened that has led to the change in perception of personnel and increase in the number of incidents in the field. The occupational stress factor was also considered in the survey after the knowledge the researcher obtained on the correlation of safety culture with occupational stress. The outcomes of this research will add to the body of knowledge on safety culture and its role in preventing incidents in a workplace. This will also remove the ambiguity surrounding the concept of safety culture which many people have. A positive correlation between the safety culture and reduced incidents at workplace will also motivate personnel's working in industries to adopt the concept easily and take it forward. It will also hopefully bring down organizational negative stress levels which contribute to change in behaviour and causation of incidents at workplace.

Review of literature :

Geller (2001) in his book The Psychology of Safety Handbook gives a detailed account of Human barriers to safety which includes cognitive failures, interpersonal factors, perceived risk, selective sensation or perception, risk compensation etc. Cooper (2001) in his book Improving Safety Culture: A practical guide clears the concept of Safety Culture, Safety Climate and how a person's perception and attitude can help in moulding a good safety culture in an organization. Many of the characteristics identified by Cooper has labelled were derived from diverse sources such as HSG (HSE, 1989); HSG (65) (HSE, 1991); goal-setting theory (Locke and Latham, 1990); behaviour modification research applied to safety (e.g. Sulzer-Azeroff, 1987); safety climate research (e.g. Zohar, 1980); accident causation models (e.g. Reason, 1990); and, studies examining organizational characteristics of high and low accident plants (e.g. Cohen, 1977). Don Brown (2016) in his article of Safety Management insights published in basicsafe blog identifies the link between stress and worker safety. He identifies how stress affects in bringing about chronic diseases and how the same can affect the safety. He identifies how factors like Poor Task Design, overbearing Management, unclear roles and unpleasant environments are contributing factors to increasing stress in workplace and thereby impacting safety. McKinsey Report on organization culture and change (November 2016) clearly identifies the concept of organizational change in the current times through the four building blocks of change. Tessa Basford and Bill Schaninger in this article identify the four building blocks of change as fostering understanding and conviction, reinforcing with formal mechanisms, Developing talent and skills and Role modelling Griffin and Neal (2000), also defined safety climate as a kind of organizational climate that an individual would experience within the organization. According to Griffin and Neal's definition, safety climate comprises the following five factors: management's values, communication, safety practices, education/ training, and safety equipment.According to Lazarus and Folkman (1984), stress occurs when the demands that are being placed upon a person tax or exceed available resources as appraised by the individual involved. When a stressful situation actually occurs, one often forgets all of the knowledge obtained on stress and how to effectively manage it. Such a response is part of being human since man is vulnerable like all other living things.Abrahamsson (2000) explained that working environment problems should be regarded as production problems in order to achieve the economic gains. Human suffering and economic losses (the loss of man power and productivity, increased cost towards medical expenses, compensation and other hidden liabilities such as replacement labour and modification of workplace) are the constant reminders to implement better organizational work design, planning of work time, work safety standard and control technologies (Nag and Patel, 1998).

Theoretical framework :

In terms of analyzing culture, Bandura's reciprocal model appears to offer the perfect framework with which to analyze organizational [safety] 'culture' for a number of reasons: First, the psychological, behavioural and situational elements of the model, precisely mirror those accident causation relationships found by a number of researchers. The potency of the Reciprocal Determinism model for analyzing 'culture', therefore, resides in the

explicit recognition that the relative strength of each source may be different in any given situation: e.g. the design of the production system may exert stronger effects on someone's work-related behaviour, than that persons attitudes. Second, its dynamic nature suits the measurement of human and organizational systems that operate in dynamic environments, particularly as the reciprocal influence exerted on each element, by the other two elements, may not occur simultaneously: e.g. it may take time for a change in behaviour to exert an influence and activate the reciprocal relationship with the work-flow system and/or work-related attitudes.Third, it provides a 'triangulation' methodology with which to encourage multi-level analyses. Triangulation refers to the 'combination of methodologies in the study of the same phenomenon, whereby multiple reference points are used to locate an 'objects' exact position. As such, given the appropriate measuring instruments, triangulation allows researchers to take a multi-faceted view of safety culture, so that the reciprocal relationships between psychological, behavioural and situational factors can be examined with a view to establish antecedents, behaviour(s), and consequence(s) within specific contexts. Moreover, triangulation lends itself to testing the external validity of the 'safety culture construct' (*i.e.* via a between-method validation process) and crosschecking each method involved in the triangulation process for internal consistency or reliability (*i.e.* via a 'within-methods' triangulation approach). Fourth, it explicitly incorporates the goal-setting paradigm advocated above via the setting of sub- goals, via task-strategies, via self-regulatory processes, and via self-efficacy mechanisms. Thinking of the measurement of safety culture in these terms, therefore, provides an organising framework to assist in ongoing practical assessments and analyses, with which the holistic, multi-faceted nature of the safety culture construct can be more fully examined in-depth.

METHODOLOGY

Problem Statement :

The proposed study intents to measure the correlation of Safety Culture in an organization with the Occupational Stress faced by personnel working at the specific worksite.

Objectives:

(i) To investigate the perception of personnel in different levels of the organization towards Safety Culture.

(ii) To investigate how Safety Culture influences workplace accident Statistics.

(ii) To investigate the influence of Occupational Stress on accident Statistics.

(iv) To compare the impact of Occupational Stress on Safety Culture.

(v) To compare the Safety Culture and Occupational Stress among Direct hired employees and subcontracted employees.

Hypothesis:

In order to fulfil the above-mentioned objectives and to deal with the research problem, following hypothesis were framed for this research study.

– H0 : There is NO change in Safety Culture of 2017-18 to Safety culture of 2018-19.

– H0 : There is NO difference in the perception of personnel in different levels of the organization towards Safety Culture

– H0: There is a significant correlation of Safety Culture on workplace accident statistics.

– H0 : There is NO significant correlation between decline in Safety Culture and Occupational Stress

Variables :

Independent Variable used int study are Safety Culture and, Ocupational Stress and Dependent Variable is the Workplace accident Statistics.

Research Design:

Keeping in view the objective and the nature of the study, correlation design is used to conduct the study.

Sample and Sampling technique:

The survey was both carried out in a digital platform and also for those without access to digital platform survey questionnaire copies were provided in both English and Hindi based on the respondent's choice. The survey divided the respondents into 4 groups for identifying the pulse of the specific group separately. The classification adopted was Senior Management- DGM and above (Including Owners for Business Partners), Managers: Assistant Manager to Sr. Manager (Including Leads and Project Managers of Business Partners), Engineers and Associates, Business Partners: All business partners (contractor) staff working with the company. The population comprising of company employees have an education level of minimum graduation and above (Table 1).

Table 1: Distribution based on Job Category	
Job Category	Number of respondents
Senior Management - DGM and above (Including Owners for Business Partners)	15
Managers: Assistant Manager to Sr. Manager (Including Leads and Project Managers of Business Partners)	78
Engineers and Associates- B and 1	115
Business Partners : All contractors	40
Total	248

In total 248 participants responded in the Safety Culture Survey which was followed by selected participant's being subjected to Occupational stress questionnaire. The study of safety culture was done in three fields of the facility namely Mangala, Bhagyam and Aishwarya. In total sample, 75% of the population respondents were from Mangala, 15% from Bhagyam and 10% from Aishwarya. Among the 75% in Mangala, thirteen personnel were in the senior management cadre with designations DGM or above who play the direct role of Management at site, sixty one personnel were from Sr. Managers to Asst. Managers cadre who are more involved with the supervisory role and communicate and implement the communique from the Management. The 75% of the respondents come from the Engineers, Sr. Engineers and Associates who were seventy six in total. The rest of the personnel in the 75% are thirty five Business partners who actively participated in the survey. Among the 15% in Bhagyam the majority of the chunk in response was received from the Engineers and Middle Management cadre with twenty five and nine responses respectively. In Aishwarya too the majority of the response was received from the Engineers and Middle management, respectively.

Business Unit	Number of Respondents
Rajasthan Oil	214
Projects	32
Corporate Functions	2

Out of the 248 participants the majority of the respondent were from Rajasthan Oil operations facility while 32 respondents were from projects and 2 from corporate functions.

Tests/ Tools:

A good questionnaire provides complete and exact information to achieve the research objectives; interviewers and respondents can fill it comfortably; and is so designed as to do comprehensive analysis and interpretation possible.

NIOSH (The National Institute of Occupational Safety and Health, Federal Agency, US) Generic job stress Questionnaire:

This model, developed by NIOSH, builds upon frameworks proposed by Caplan, Cobb, French, Harrison, and Pinneau (1975), Cooper and Marshall (1976), and House (1974). In this scheme, Job Stressors refer to working conditions that may lead to Acute Reactions, or strains in the worker. These short-term strains, in turn, are presumed to have an impact on longer-term indicators of mental and physical health. Three other components are included in the model: Individual Factors, Non-work Factors, and Buffer Factors. These categories encompass a variety of personal and situational factors that seem to lead to differences in the way individuals exposed to the same job stressors perceived and/or react to the situation.

Reliability and Validity:

The scale measures for this scale were chosen from the literature based upon previously documented reliability

Table 2 : Cronbach's alpha values of different factor sin NIOSH questionnaire		
Factor	Factor Name	Alpha
02	Role Conflict	0.82
04	Intragroup Conflict	0.86
05	Intergroup Conflict	0.85
07	Perceived Control	0.90
23	Task Control	0.85
24	Decision Control	0.74
25	Physical Environment Control	0.79
26	Resource Control	0.82
08	Lack of Alternate Opportunity	0.80
09	Social Support from Spr	0.88
10	Social Support from Cwrk	0.84
11	Social Support from Family	0.85
12	Quantitative Workload	0.85
13	Variance in Workload	0.86
14	Responsibility for People	0.62
15	Reverse Skill Underutilization	0.73
16	Mental Demands	0.75
19	Self-Esteem	0.85
20	Somatic Complaints	0.87
21	Reverse Job Satisfaction	0.83

and validity while creation of the same by NIOSH. The document "Rationale for NIOSH Generic Job Stress Questionnaire" has been published by NIOSH which details further on the validity of the questionnaire. The questionnaire along with the keys are attached as Annexures to the report. Reliability of the scale has been proven by the past data's provided in the Scoring Key for NIOSH Generic Job Stress Questionnaire (Table 2).

From the questionnaire only the factors with high Cronbach alpha which are mentioned above were chosen for carrying out the survey to ensure high reliability.

Safety Culture Survey Questionnaire:

To collect the information, a 33 questions questionnaire was constructed by the researcher taking relevant questions and rewording the questions from well-established safety culture survey questionnaires like NOSACQ 50, Loughborough Offshore Safety Climate Assessment etc to suit the requirement of an upstream onshore Oil & Gas industry. Sample of the Questionnaire is also attached as an annexure for reference. Information about personnel's understanding and orientation towards safety culture will be collected for the deeper analysis through these set of specific questions. The primary data was collected online through forms.

Validity:

Face validity of the questionnaire had been established by discussing with industry experts on whether the questions appear valid for experienced industry users and thus have been validated. Similar questionnaires have been used by world reputed Safety companies like DuPont (The patented owner of DuPont Bradley Curve) and test reliability and validity have been proved.

Reliability:

The internal consistency reliability of our Safety Culture survey was tested using the Cronbach's alpha statistic based on the collected data. The data was shown to have a Cronbach's alpha of 0.91183315 and demonstrated to have very good internal consistency reliability, with value exceeding .70 as recommended by Nunnally (Table 3).

Anova was found by taking the value 1-(MS Error/ MS Rows)=1-(0.645617161/7.322674416)=0.91183315

Data Collection :

The survey framework once finalized was launched through mail by the in charge of the facility and the timeline for providing feedback was fixed to one week. All the participants from the company were given the direct link to the survey form which was hosted in the company server. The instructions for filling the survey form was provided at the start of the survey and the data.

Statistical Analysis:

Windows Excel Spreadsheet's Data analysis tool pack was used for recording and classification of samples.

Simple Percentage Analysis:

Simple percentage analysis is one of the basic statistical tools which is widely used in the analysis and interpretation of the main data. It deals with the number of respondents' response to a particular question in percentage arrived at the total. Simple percentages was used in the study to analyse the factors like demographic and other details of the respondents and was predominantly used for Safety Culture study.

t-Test:

The independent samples t-test was used with two separate sets of independent and identically distributed samples obtained, for example in our case managers feedback from one location was compared to managers feedback from different location. Also the same was carried out in case of engineers, Business partners and DGM's response in one location from another location. The Pearson product-moment correlation coefficient is a measure of the strength as well as the direction of the linear relationship between two variables. Thus product moment correlation developed by Karl Pearson is used to test each Hypothesis.

Table 3 : ANOVA

Source of variation	SS	df	MS	F	P-value	F crit
Rows	1801.377906	246	7.322674416	11.34213101	0	1.155501033
Columns	4684.229497	34	137.7714558	213.3949718	0	1.430899831
Error	5399.941932	8364	0.645617161			
Total	11885.54933	8644				

ANOVA:

Analysis of variance is an elegant and versatile technique. It is being widely used in determining whether or not the means of more than two samples are equal. Basically, it is a procedure by which the variation is analysed into its various components corresponding to the various sources of variation. Thus, the ANOVA is a method of splitting the variance for analytical purposes for testing the difference between different groups of data for homogeneity. This technique in short is referred to as ANOVA and enables us to make inferences abou whether samples are drawn from populations having same means. ANOVA two factor without replication was used in our case and analysed through the provided data analysis tool pack in excel.

RESULTS AND DISCUSSION

Descriptive statistics pertaining to the priority given to safety by each group is shown below where it is clearly evident that 92% of individuals feel that they rate safety at the highest priority. Only 80% of their immediate managers feel safety to be their first priority and followed by Business Partners at only 44%. The feeling that 40% of business partners give most importance to cost is an alarming figure as it clearly indicates a trend where outsourcing projects are giving less importance to safety and cutting costs to save money and thereby trending for a degenerative safety culture. Only 83% and Engineers who work in the shop floor feel that it can only be averted 66% of the time. This is a very serious awakening for the management as it shows that the percolation of the thought process of the management has towards accident prevention is not getting percolated down to shop floor employees. The alarming thing in this is the 7% in management opted to vote for the option that a world class safety culture will jeopardize the ability to accomplish the business goals. That shift in thought process is a very bad sign that a good safety culture will be given least importance as it is thought to be hindrance in the progress of business. In the current culture it was clearly evident that Sr. managers have given the true feedback that they are not accountable for safety and in fact the safety accountability has gone down 20% when compared to the previous year. The involvement of leadership in safety committees, incident investigation and reviewing or developing safety rules has definitely increased in the past one year which is a very good indicator but the overall involvement has gone down by 18%.The survey shows that, Managers don't feel that much empowered as earlier to take action on seeing an unsafe act/ condition. The average industrial training rate is one to two weeks per year of training whereas in this facility it was noticed the training hours have further dropped down. Overall response to the Safety meetings being carried out vary from once or twice a week to more than two months. While management has participated in 75-100% of the meetings. The Sr managers and engineer levels have varied level of participation. Safety meeting is an important part of the safety culture where everyone is shared with the information on incidents and its root causes, advancements in safety, themes which can be carried to workplaces. The overall participation and the participation by business partners and employees have gone down which needs to be addressed on priority. The senior management believe that the safety practices and procedure in our organization are not very effective. An organization with poor safety practices and procedures can never expect to triumph in a magnificent safety culture. The procedures and practices are basically the guidelines for carrying out activities safely, if these are missing or not well understood its effectiveness is lost. The employees are under pressure when the work schedule is stretched and they are forced to bypass safety for getting the work done if the schedule is tight. The management is more willing to sidestep safety and this has a direct correlation with the number of accidents increase in the facility.

The question about effectiveness of consequence matrix shows how effectively action is taken against violators of safety standards. The senior managements response from the past years 58% to 27% is really amusing. The managements open response that the violations are only acted upon 27% as per the consequence management is really not a good sign to healthy safety culture. The shift in culture is also visible with the shift from 58% previous year to this year's 27%. In a healthy safety culture, all incidents are reported and investigated with the emphasis on near- miss to prevent future incidents from happening the same is clearly missing here. The same is evident from the response provided by management at 33%. The involvement of senior management in safety reviews has gone up from 46 to 80% the same is a very commendable achievement for a positive safety culture. But on the same time involvement of business partners has gone down from 79% to 68%. This needs to be rectified and overall

response to safety reviews by team has to be strengthened. The quality of safety audits have fallen down considerably in spite of greater involvement of management in audits and reviews when compared to the previous year and is not a good sign of positive safety culture. The company has very few off-the job safety initiatives as per the response. On digging further into details, it was found that there exist no safety initiatives outside work place and the actual status is same as per previous year. But the response from personnel shows they are slowly losing faith in whatever goodwill programmes the management used to do earlier and don't expect even that to happen in the future. The recognition level for positive safety behaviour has further gone down from the past year with all groups scoring lesser except the engineers. The business partners response is the most alarming as it has dropped down to nearly 50% from the past year values. A good safety culture requires constant motivation from the management and recognition plays a key role in the same.The company also does not publish data comparing its position with the international companies in terms of safety benchmarks which clearly shows the lack of the information among all groups. The same has also fallen down considerably when compared to the previous year.The disagreement of all groups to this answer clearly shows that safety accountability is not owned by management and they expect it to be the accountability of the HSE department. A proactive safety culture is the one in which everyone is accountable for safety of themselves and others working with them. The same is clearly missing in this picture. The question about competency and effectiveness of safety professionals in workplace has fallen down to its ever low with the Senior management acknowledging it at just 13% and the overall respondents at 28%. This clearly indicates that the groups don't have confidence in their HSE professional's competency to lead them in matters of HSE.

The question about critical risks and their controls and how they are managed in asset has garnered a good response and whatever the action management has taken to improve on the same from previous year has proven to be on the right track and this will slowly help in establishing a positive safety culture and needs to be carried forward in the coming years too.No actionable things can be done if resources are invested on the same. The question no. 26 clearly identifies that management does not facilitate resources required for achieving high standards and safety performance. This is a big detriment to building a positive safety culture.Process safety management practices and parameters seems to have gone down further from the previous year which is an alarming situation, the same is also a sign of deterioration of safety culture from the previous year. A company learns a lot from the best practices in other companies, especially well established practices in other groups and also industry pioneers. The same is clearly missing here with all the groups identifying the lack of the same. For a proactive safety culture to develop a formal system for identification of these best practices at group level should exist and a proper channel for the communication of the same is important. Management of Change process is a very critical one where any change which effects the plant is taken into account. For a company any organization change/people related change also effects its process. The senior managements response that it is not followed with the same rigor as technical MOC is not a good sign. This parameter has fallen down considerably in all the groups response. The extend of operational discipline followed by personnel in the construction and maintenance procedures is not a very good sign where senior management thinks its followed in all the procedures but the managers, superintendents, engineers and business partners think on the contrary. This is clear contradiction to the belief system of management where management is expecting something positive to be happening but on the contradictory the reverse is happening in the field. The fatal risks have garnered significant positive momentum among groups of respondents in the previous year. With the steps taken for improvement of the same it is a positive moment towards proactive safety culture and needs to be further improved among all groups.

A critical question as it clearly shows that all the groups faith that equipment's which were being maintained as per high standards of asset integrity, reliability has gone down further. This was correlated further with the accident statistics of the same firm and was found that the number of failures of pipelines, equipment's etc. have considerably increased in the past year. The descriptive analysis clearly shows that the safety culture has gone down from the previous year when compared to this year and when compared to international benchmarks of good safety culture which is all of the scores above minimum of 90%. The company is lacking seriously in catching up to a proactive safety culture.

Incident Statistics correlation with Safety Culture for the period 2017-18 to 2018-19:

The accident statistics of the location were compared with the safety culture trend as shown by the survey. The same was found to be in sync with the survey report, there has been considerable change in the safety culture from the previous year to this year. As correlated by many studies in the past the same has been clearly established here through descriptive statistics. The decline noted in safety culture is directly correlating with accidents Statistics. The number of fatalities have gone up from 1 to 3 people in the period of comparison, which is nearly 3 times. For LTI cases the same has gone up by twice to 11 number of Lost time incidents, which are in other words major injuries which prevent people from reporting back to duty in 24 hours. Which includes cases of fracture, major cuts haemorrhage etc. resulting in hospitalization and unable to report to duty for more than 24 hours.

Incident statistics also reflect drastic increases in the number of first aid cases which has gone up from 22 to 39. *i.e.* a rise by 77% when compared to the previous year. Near miss incidents which could have resulted in serious injuries but did not happen due to chance of the person not coming in contact with the energy source has also gone up by 77%. The reporting culture of these incidents are a good trend, but unless strong action is taken for preventing all incidents including near miss the safety culture will not improve and only further deteriorate.

t-Tests :

t-Test – Safety Culture 2017-18 to 2018-19

The t-Test of the overall stats of 2017-18 safety culture (obtained from industry) was run along with 2018-19 (carried out by the researcher) and the following was obtained (Table 4).

Table 4 : F-Test Two-Sample for Variances

	2017-18	2018-19
Mean	69.34375	57.34375
Variance	186.7489919	510.297379
Observations	32	32
df	31	31
F	0.365961103	
P(F≤f)one-tail	0.00325344	
F Critical one-tail	0.548807573	

During the F-Test it was found that the probability is less than 0.05 hence it was decided to carry out a t-Test for two sample assuming unequal variances.

Hence on carrying out t-Test for sample assuming that variances are unequal the following data was obtained (Table 5).

Table 5 : t-Test : Two-Sample Assuming Unequal Variances

	2017-18	2018-19
Mean	69.34375	57.34375
Variance	186.7489919	510.297379
Observations	32	32
Hypothesized Mean Difference	0	
df	51	
t Stat	2.571138077	
P (T≤t)one-tail	0.006548203	
t Critical one-tail	1.67528495	
P(T≤t) two-tail	0.013096405	
t Critical two-tail	2.00758377	

The alpha for the same was taken as 0.05. As from the studies it was found that p(T≤t) two-tail was found to be less than the alpha there exists significant difference in the safety culture of 2017-18 when compared to 2018-19. Thus the null hypothesis H0 assumed that there is no difference between the safety culture stands rejected.

t-Test between different groups on perception to safety culture with Type I error adjusted:

First F-test was done for finding variances and once the results of the variances was obtained it was decided to go t-Test for two samples assuming equal variances.

The result of the F-test carried out are as below and all the p values are higher than alpha calling in for a t-Test with equal variances (Table 6, 7 and 8).

Table 6 : F-Test: Two-Sample for Variances : Sample 1 to 2

	DGM's	Sr. Managers
Mean	58.59375	51.65625
Variance	609.345766	999.458669
Observations	32	32
df	31	31
F	0.6096758	
P(F<f) one-tail	0.08696876	
F Critical one-tail	0.4146052	

Table 7 : F-Test Two-Sample for Variances : Sample 2 to 3

	Sr. Managers	Engineers
Mean	58.59375	56.1875
Variance	609.345766	481.96371
Observations	32	32
df	31	31
F	1.26429802	
P(F≤f) one-tail	0.2588512	
F Critical one-tail	2.41193309	

Table 8 : F-Test Two-Sample for Variances : Sample 3 to 4		
	Engineers	Business Partners
Mean	56.1875	60.28125
Variance	481.96371	455.628024
Observations	32	32
df	31	31
F	1.05780085	
P(F≤ f)one-tail	0.43834533	
F Critical one-tail	1.82213229	

Proceeding with t-Test for equal variances on the above samples with a adjusted for Type I error and taking the value of alpha as 0.05/6 = 0.0083333 (Table 9, 10 and 11)

As proven from the t-Tests carried out above all the p values are more than the a value of 0.0083333 hence there exists no significant difference between the samples. Thus the assumed hypothesis H0 that there is NO difference in the perception of personnel in different

Table 9 : t-Test :Two-Sample Assuming Equal Variances			t-Test :Two-Sample Assuming Equal Variances		
DGMs		Mgrs.		Mgrs.	Engg.
Mean	51.65625	58.59375	Mean	58.59375	56.1875
Variance	999.458669	609.3457	Variance	609.345766	481.9637
Observations	32	32	Observations	32	32
Pooled Variance	804.402218		Pooled Variance	545.654738	
Hypothesized Mean Difference	0		Hypothesized Mean Difference	0	
df	62		df	62	
t Stat	-0.9784223		t Stat	0.41204227	
P(T≤t)one-tail	0.16583397		P(T≤t)one-tail	0.3408648	
t Critical one-tail	2.46068573		t Critical one-tail	2.46068573	
P(T≤t) two-tail	0.33166793		P(T≤t) two-tail	0.6817296	
t Critical two-tail	2.72556503		t Critical two-tail	2.72556503	

Table 10 : t-Test: Two-Sample Assuming Equal Variances			t-Test : Two-Sample Assuming Equal Variances		
DGMs		Engg.	DGMs		BP's
Mean	51.65625	56.1875	Mean	51.65625	60.28125
Variance	999.458669	481.963	Variance	999.458669	455.6280
Observations	32	32	Observations	32	32
Pooled Variance	740.71119		Pooled Variance	727.543347	
Hypothesized Mean Difference	0		Hypothesized Mean Difference	0	
df	62		df	62	
t Stat	-0.6659683		t Stat	-1.2790563	
P(T≤ t)one-tail	0.25395086		P(T≤ t)one-tail	0.1028219	
t Critical one-tail	2.46068573		t Critical one-tail	2.46068573	
P(T≤t) two-tail	0.50790172		P(T≤t) two-tail	0.2056438	
t Critical two-tail	2.72556503		t Critical two-tail	2.72556503	

Table 11 : t- Test :Two-Sample Assuming Equal Variances			t- Test :Two-Sample Assuming Equal Variances		
Engg.		BP's	Mgrs.		BP's
Mean	56.1875	60.28125	Mean	58.59375	60.28125
Variance	481.96371	455.6280	Variance	609.345766	455.6280
Observations	32	32	Observations	32	32
Pooled Variance	468.795867		Pooled Variance	532.486895	
Hypothesized Mean Difference	0		Hypothesized Mean Difference	0	
df	62		df	62	
t Stat	-0.7562919		t Stat	-0.2925158	
P(T≤ t)one-tail	0.2261692		P(T≤ t)one-tail	0.3854345	
t Critical one-tail	2.46068573		t Critical one-tail	2.46068573	
P(T≤t)two-tail	0.45233841		P(T≤t)two-tail	0.77086899	
t Critical two-tail	2.72556503		t Critical two-tail	2.72556503	

levels of the organization towards Safety Culture stands accepted.

t-Test to identify the correlation of Safety Culture on workplace accident statistics:

To identify whether the variances are equal or unequal a F-test was initially carried out with the given data. The details of the F-test are as below (Table 12).

Table 12 : F-Test : Two-Sample for Variances

	Safety Culture	Incident data
Mean	57.34375	47.8
Variance	510.297379	5001.7
Observations	32	5
df	31	4
F	0.10202479	
P(F≤f)one-tail	3.0345E-05	
F Critical one-tail	0.37332	

As the p value was found to be far less than the value of a it was decided to go ahead with a t-Test for two samples assuming unequal variances (Table 13).

Table 13: t-Test: Two-Sample Assuming Unequal Variances

	2018-19	2018-19
Mean	57.34375	47.8
Variance	510.297379	5001.7
Observations	32	5
Hypothesized Mean Difference	0	
df	4	
t Stat	0.29937182	
P(T≤t) one-tail	0.38978356	
t Critical one-tail	2.13184679	
P(T≤t)two-tail	0.77956712	
t Critical two-tail	2.77644511	

As proven from the t-Tests carried out above the p value is significantly higher than the a value of 0.05 hence there exists no significant difference between the samples. Thus the assumed hypothesis H0 that there is significant correlation of Safety Culture on workplace accident statistics is accepted.

t-Test to identify the correlation of occupational stress and safety culture:

To identify whether the variances are equal or unequal a F-test was initially carried out with the given data. The details of the F-test are as below (Table 14):

As the p value was found to be less than the value of a it was decided to go ahead with a t-Test for two samples assuming unequal variances (Table 15).

Table 14 : F-Test Two-Sample for Variances

	Occupational Stress	Safety Culture
Mean	4.65925926	5.53125
Variance	2.82332781	4.64415323
Observations	135	32
df	134	31
F	0.60793167	
P(F≤f) one-tail	0.02826435	
F Critical one-tail	0.65059314	

Table 15 : t-Test:Two-Sample Assuming Unequal Variances

	Occupational Stress	Safety Culture
Mean	4.65925926	5.53125
Variance	2.82332781	4.64415323
Observations	135	32
Hypothesized Mean Difference	0	
Df	40	
t Stat	-2.1399378	
P(T≤t) one-tail	0.0192559	
t Critical one-tail	1.68385101	
P(T≤ t)two-tail	0.03851179	
t Critical two-tail	2.02107539	

The p value was found to be less than the value of a which was taken as 0.05. From the studies it was found that p(T≤t) two-tail was less than the alpha so the null hypothesis H0 assumed that there is no correlation between the decline in safety culture and occupational stress stands rejected. The same has been proven earlier too in many literatures that there is a strong correlation between increase in occupational stress and decline in safety culture which has been again proven here.

Conclusion and Implications:

From the study it can be concluded that Safety culture plays a major role in any industry in regulating the work culture and also keeping the incident in control. With the current figures and results from the survey and its comparison and correlation study with the past data it has become clear that the safety culture in the organisation has declined from the past year. Also the increase in the number of incidents from the past with respect to injury and death of people is a major concern and correlates with the decline in safety culture noticed in the industry. Even though the management and personnel working in the organization realize and believe that a positive safety culture and improvements in safety

is essential and is the need of hour for reduction in number of accidents and other issues plaguing the site like increase in failure of equipment's and piping. The urge seems to be missing from the board towards pushing the requirement of safety.

The research clearly indicates the strong correlation of Safety culture with accident statistics. This has got potential that any company which wants to reduce the number of accidents can slowly work on their safety culture thereby developing it positively and eliminating accidents from their workplace and also increasing productivity.

For the improvement of safety culture in the company the company can take an organized approach in the below mentioned steps:

– The visible leadership commitment has to be shown in all levels of the organization.

– The awareness of health and safety topics need to be increased throughout the organization and the process owners to be made accountable for safety. They have to own it up, this was being clearly seen to have fallen down over the period of year and needs to be reinstated.

– The values the company wants to ingrain into the culture of the organization needs to be clearly defined and to be ensured is circulated and received till the shop floor and the contract workforce.

– For a proactive safety culture – Safety has to come first every time then only things can improve. If it's on variable priority it will never have the momentum to change the culture.

– As mentioned earlier the company clearly needs to allocate resources for safety and integrity in line with the vision to create a proactive safety culture.

– The current trend which was seen in the company was a fire fighting mode where optimization had driven the bottleneck around manpower and resources. This results in hampering a safety culture. Optimal resources to be provided so that opportunities for improvement can be identified and rectified immediately.

– The communication on health and safety topics need to be regular and facility-wide. The same needs to be consistent across each group.

– The consequence managements effectiveness was not seen, this needs to be reinstated with the purpose it was created. A fair and just discipline system has to be in place for all employees.

– Everyone in the organization needs to have a meaningful involvement in health and safety, as discussed above accountability has to be taken by everyone for their workplace safety. HSE department will have to step into the role of advisors.

– Sr. Management and middle management has to spend more time in the field and sites to understand the pulse of the workforce. The current disconnect between the two groups can be resolved only that way.

– Off-the Job safety initiatives where seen to be at all time low. This needs to be reversed by actively engaging employees to produce tangible results for the company.

– Safety has to be taken up as the first agenda of every meeting, this puts out the importance of safety to all workforce.

– Employees have to be given more freedom for reporting their safety issues to the supervisors, this will drive in a culture where more reporting takes place and rectification of the same can happen on time. Also this helps in making us aware of similar issues from happening in the future.

– Rewards and recognition programme had been found to have gone down, the recognition of personnel plays a major role in building up a positive safety culture and needs to reinstated on priority.

– Managers and supervisors have to respond positively to safety issues which are raised. The trend which was currently seen is people raising safety issues and managers acknowledging the same but no action was being seen taken at site to rectify the same due to shortage of resources. This slowly results in the employees losing the urge to report safety issues.

– In the case of incident reporting also it was seen that many incidents were selectively reported and investigated. The culture which has crept in now to sweep it under the rug has to be changed.

– Employees including managers and even Business partners have to be empowered to stop work and fix the problems if they see them.

These steps can help in building up a proactive safety culture for the company.

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