A Study of Employees "Health and Safety Daily Work Routine" Observation in Manufacturing Industry

Kundan Chandrakar
M. Tech Student
Department of Industrial Safety Engineering
Bhilai Institute of Technology, Raipur, India

Abstract— Behavioral science is not a new topic for the industry of occupational health and safety, as its roots can be traced to 1876, wherein two different fields of science of behavioral science and industrial safety are combined to create behavior based safety program for increasing safety of the workforce, as it often happens that the worker behavior is often tied to as immediate cause in case of workplace accident or injury. In this study a review on the present behavior based safety program, the targeted behavior. Further on, the study also aims to investigate if the process of the behavior based safety program is in control or not using the run charts from Statistical Control Techniques (SPC).The objectives of the study is to investigate the effects of the fundamentals of the behavior based safety program on the Safety Acts Index It can be deduced that though the percentage on the Safety Act Index has improved, the control charts show a different picture where the entire process is out of control despite there being an improvement on the run charts, which conforms with fact that the factory and industry is still in development stage where there is room for immense development. Another problem that was commonly given in the feedback is the lack of management commitment of leadership, inability of the leadership to appreciate the hazards and over importance given to bring productivity as compared to giving equal importance on safety and production.

Keywords: Health and Safety, Work Routine, Manufacturing Industry, Statistical Control Techniques (SPC)

I. INTRODUCTION

Behavioral science is not a new topic for the industry of occupational health and safety, as its roots can be traced to 1876, wherein two different fields of science of behavioral science and industrial safety are combined to create behavior based safety program for increasing safety of the workforce, as it often happens that the worker behavior is often tied to as immediate cause in case of workplace accident or injury. Though there are many engineering and management practices like substitution, elimination, administrative controls, personal protective equipment, etc. which have contributed immensely to the occupational health and safety by reducing the incident rates, severity and frequency however their numbers still remain disturbing to the organization, government and customers whose immediate causes are often the worker behavior. Hence, the need for changing the behavior of the workers through behavior based safety programs.

A study was conducted on analysis of accident trends & modeling of safety Indices on major construction organization in India to examine the trends in safety Indices from the period 2008-2014 in the year 2016. They plotted & determined the trends of safety indices incidence rate, severity rate & frequency rate. They determine the relationship between safety indices frequency rate severity rate, total man hours worked, number of near misses, number of lost time injury, allocation of safety budget & number of safety activity conducted by modeling the pattern of safety indices. The pattern showed that there is significant relationship exist between safety indices frequency, severity & incidence rate & the related independent variables near misses & safety budget allocation which influencing the associated safety indices valve

After the implementation of Behavior Based Process have claimed that they could feel that a change in the Safe Acts Index (% of Safe Acts) was a three-week predictor of an accident. This means that the observation and feedback techniques of BBS may be used to predict that safety problems may be growing in any facility or not and thus preventing any untoward incident and there use in also disclosing inefficient operating procedure, unsafe practices & improper supervision which are responsible of accident. This is a uniform system of recording the industrial accident associated with work injuries & determination of preventive corrective measures it's provide method to find out Injury rate for comparing safety performance & prescribed method for further classification of accidents for assessment of work injury.

II. METHODOLOGY DURING ON STUDY

The project work during the port happened in a very streamlined manner under the guidance of the head of department of Health, Safety, Environment and Fire Department as follows:

- The first step was a two week induction program of the major and minor areas of the industry as per the company policy.
- Next step was the study of the behavior based safety program that has been followed at the industry in detail.
- The next step was the project allotment where in the project of above mentioned topic (on cover) under the head of department of health, safety, environment and fire.
- The behavioral observations that are to be analyzed was collected as the from the company database.
- Further on, study of the statistical process control techniques theory and the basics on application of the theory was conducted.
- The data was to be analyzed was selected as per the guidance of my mentor at the organization, i.e. the head of department of health, safety, environment and fire department.
- The percentage safe behavior was calculated for the time frame selected.
- The trend of the positive observations (safe behaviors), unsafe acts and unsafe conditions behaviors was plot,

after categorizing among the major three departments of concer

– The p-chart was plot for that are under the study for trend analysis (since when the behavior based safety program.

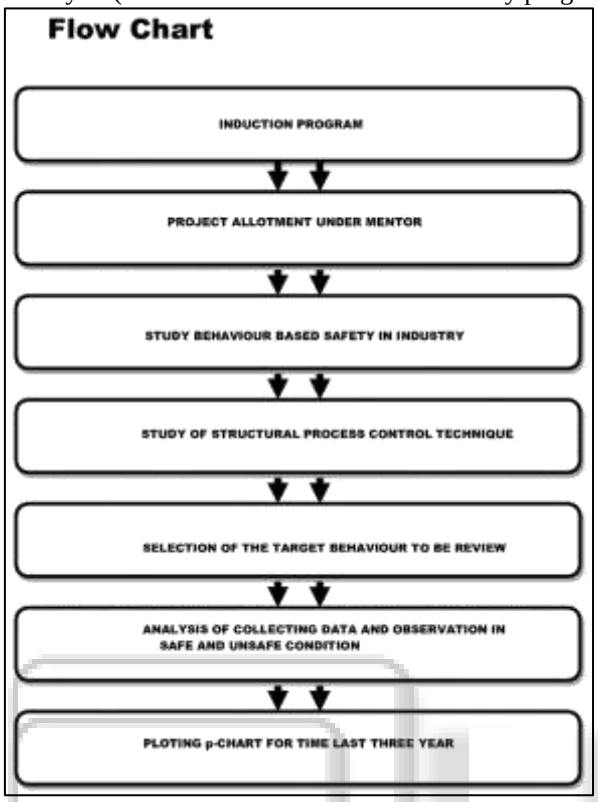


Fig. 1: Flowchart of Methodology

III. BEHAVIOR BASED SAFETY PROGRAMS -

Behavior-based safety programs though being common in terms of certain elements listed below, they differ in various organizations on basis of complexity and extent of application. Safety identify the following fundamental requirements:

1) Target Behaviors have to identified
2) data Analysis- safety indices of each year are compared with those of previous years
3) Develop a simple yet precise method for logging behavior observations and provide proper training to the observers
4) For thorough and consistent measurement develop clear definitions in order to maintain focus and leave no room for ambiguity
5) A suitable intervention method must be created which provides positive reinforcement and feedback about the safe work practices and target behaviors.

Find out the deficiency or draw back in safety management system & to suggest the safety measures area where safety improvement is necessary to raise its safety performance & prevent further reoccurrence of same type of accidents Using percentage of safe behavior Methods include data from the safety supervisors, managers, industry experts, injury records, near-miss reports and accidents. Identification of behavior also creates a need for making a clear & precise definition of all the identified behaviors. Thereafter, an observation checklist is generated. Then the observer would record observations as safe or unsafe using the checklist in the field. The time duration for observation should be long enough to determine the type of behavior as safe and unsafe (here, it should be noted that the employees should be aware about the Behavior Based Safety process). Using the observations we can calculate the percentage safe behavior.

IV. PERCENTAGE OF SAFE BEHAVIOUR FOMULAR

$$\text{PERCENTAGE OF SAFE BEHAVIOUR} = \frac{\text{TOTAL NUMBER OF SAFE BEHAVIOUR OBSERVED}}{\text{TOTAL NUMBER OF BEHAVIOUR OBSERVED}}$$

This behavior can be explained in terms of ABC model given below.

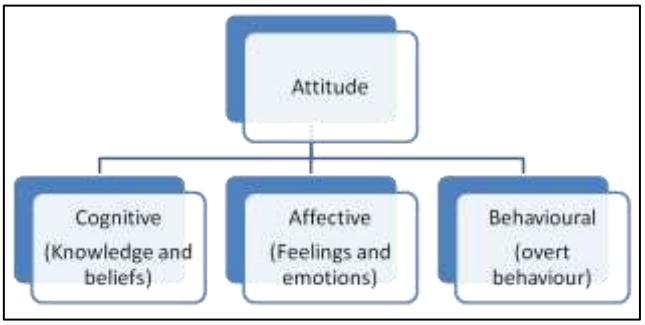


Fig. 2: ABC Model

Just as the quality characteristics of a process are measured, behavior based safety can be treated as a process and its characteristics should be measured. Statistical Process Control Techniques are used to analyze any process for quality control and management which can be applied for the behavior based safety program to analyze the characteristics. Behavior observations are an example of leading safety performance indicators which helps organizations to proactively manage safety & predict any problems before an incident or injury occurs. The simplest way to represent the behavioral observations in graphical form is by using run charts (p charts, u charts, etc.). This provides information on the stability of behavior based safety process before any changes are provided. Stewart gave the concept of Statistical Process Control techniques based on the fundamental concept of understanding changes in process through changes in variation, namely "common cause" variation and "special cause" variation

Type of accident, unsafe act or unsafe condition, unsafe personal factor, nature of injury & location of injury these classification of accidents provides root cause which was involving in lost time injury & man days lost. The trending of accident statistics data from previous years is necessary for appraisal of safety performance. The principal aim of safety performance appraisal is to find out limitation or deficiency or Area where safety improvement is necessary by designing all operation system safe & efficient

V. DATA COLLECTED

The data collected here are the total observations from the month of application of behavior based safety program till November, 2019. These observations are namely classified into positive observations, unsafe conditions and unsafe acts. The percentage safe behavior is calculated using the data and represented using the graph.

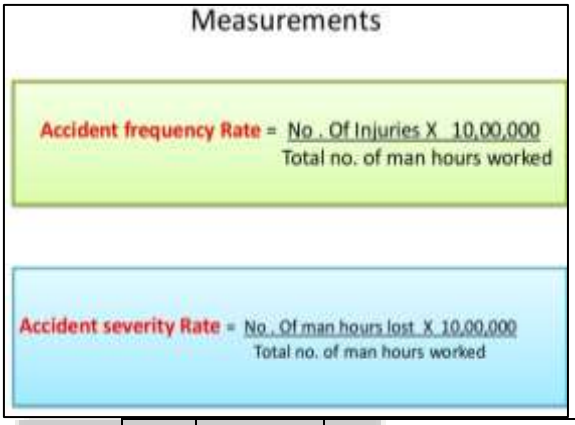
The data is then used to generate p-charts for variable sample size, for which p-bar, upper control limit, lower control limit and the proportion of safe behavior among total behaviors is calculated and represented.

A. Formulas

1) Frequency rate (F.R):- Number of lost time injuries per million man hours worked.

$$F.R. = \frac{\text{NUMBER OF LOST TIME INJURY}}{\text{TOTAL MAN HOURS WORK}} * 1000000$$

2) Severity Rate (S.R): Number of man –days lost per million man hours worked



– Total Observations = Unsafe Act + Positive Observations
– Proportion = (Positive Observations / Total Observations
– p bar = (Sum of Total Positive Observations / Sum to Total Observations)
– Control Limits are by:

$$CL_{\bar{p}} = \bar{p} \pm 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

Fig. 3: Equation for Control Limits

Where, n = total observations
p = proportions

NO.	MONTH	POSITIVE OBSERVATION	UNSAFE ACT	UNSAFE CONDITION
1	JUN 16	0	1	0
2	JUL 16	4	140	89
3	AUG 16	10	120	130
4	SEPT 16	9	59	187
5	OCT 16	16	48	122
6	NOV 16	21	53	131
7	DEC16	30	66	132
8	JAN 17	31	59	121
9	FEB 17	40	74	191
10	MAR 17	33	84	142
11	APR 17	43	82	140
12	MAY 17	34	92	129
13	JUN 17	39	105	130
14	JUL 17	45	106	129
15	AUG 17	50	102	138
16	SEP 17	54	111	139
17	OCT 17	59	118	120
18	NOV 17	41	129	136
19	DEC 17	49	117	139
20	JAN 18	56	108	129
21	FEB 18	51	106	119
22	MAR 18	49	112	130
23	APR 18	60	110	120
24	MAY 18	55	117	129
25	JUN 18	62	119	116
26	JULY 18	61	117	136
27	AUG 18	54	128	138
28	SEP 18	61	117	136
29	OCT 18	65	123	126
30	NOV 18	59	129	136
31	DEC 18	67	128	136
32	JAN 19	79	117	121
33	FEB 19	71	121	129

34	MAR 19	70	129	130
35	APR 19	79	124	129
36	MAY 19	72	123	134
37	JUN 19	81	122	129
38	JULY 19	84	121	122
39	AUG 19	75	119	138
40	SEPT 19	79	127	140
41	OCT19	81	132	134
42	NOV 19	89	129	139

Table 5.1:

NO.	MONTH	POSITIVE OBSERVATION	TOTAL(ni)	% OF SAFE BEHAVIOR	PROPORTION (pi)
1	JUN 16	0	1	1.7167	0
2	JULY 16	4	233	3.8461	0.01716
3	AUG 16	10	260	3.5294	0.03846
4	SEPT 16	9	255	8.6021	0.03529
5	OCT 16	16	186	8.6021	0.08602
6	NOV 16	21	205	10.2439	0.10243
7	DEC 16	30	228	13.1578	0.13157
8	JAN 17	31	211	14.6919	0.14691
9	FEB 17	40	305	13.1147	0.13114
10	MAR 17	33	259	12.7413	0.12741
11	APR 17	43	265	16.2264	0.16226
12	MAY 17	34	255	13.3333	0.13333
13	JUN 17	39	274	14.2335	0.14233
14	JULY 17	45	280	16.0714	0.16071
15	AUG 17	50	290	17.2413	0.17241
16	SEPT 17	54	304	17.7631	0.17763
17	OCT 17	59	297	19.8653	0.19865
18	NOV 17	41	306	13.3986	0.13398
19	DEC 17	49	305	16.0655	0.16065
20	JAN 18	56	293	19.1126	0.19112
21	FEB 18	51	276	18.4782	0.18478
22	MAR 18	49	291	16.8384	0.16838
23	APR 18	60	290	20.6896	0.20689
24	MAY 18	55	299	18.3946	0.18394
25	JUN 18	62	297	20.8754	0.20875
26	JULY 18	61	307	19.8697	0.19869
27	AUG 18	54	320	16.8750	0.16875
28	SEPT 18	61	314	19.4267	0.19426
29	OCT 18	65	314	20.7006	0.20700
30	NOV 18	89	322	18.3229	0.18322
31	DEC 18	67	331	20.2416	0.20241
32	JAN 19	79	317	24.9211	0.24921
33	FEB 19	71	320	22.1875	0.22187
34	MAR 19	70	329	21.2765	0.21276
35	APR 19	79	332	23.7951	0.23795
36	MAY 19	72	329	21.8844	0.21884
37	JUN 19	81	332	24.7706	0.24770
38	JULY 19	84	327	25.6880	0.25688
39	AUG 19	75	332	22.5903	0.22590
40	SEPT 19	79	346	22.8336	0.22833
41	OCT 19	81	347	23.3429	0.23342
42	NOV 19	89	357	24.9299	0.24929

Table 5.2: Percentage Safe Behaviour Calculated

NO.	MONTH	PROPORTION (P)	p-BAR	UPPER CONTROL LIMIT	LOWER CONTROL LIMIT
1	JUN 16	0	0.031	0.06506	0
2	JULY 16	0.01716	0.031	0.06506	0

3	AUG 16	0.03846	0.031	0.06324	0
4	SEPT 16	0.03529	0.031	0.06356	0
5	OCT 16	0.08602	0.031	0.06912	0
6	NOV 16	0.10243	0.031	0.06731	0
7	DEC 16	0.13157	0.031	0.06543	0
8	JAN 17	0.14691	0.15	0.22374	0.07625
9	FEB 17	0.13114	0.15	0.21133	0.08866
10	MAR 17	0.12741	0.15	0.21656	0.08343
11	APR 17	0.16226	0.15	0.21580	0.08419
12	MAY 17	0.13333	0.15	0.21708	0.08291
13	JUN 17	0.14233	0.15	0.21471	0.08528
14	JULY 17	0.16071	0.15	0.21401	0.08598
15	AUG 17	0.17241	0.15	0.21290	0.08709
16	SEPT 17	0.17763	0.15	0.21143	0.08856
17	OCT 17	0.19865	0.15	0.21215	0.08784
18	NOV 17	0.13398	0.15	0.21123	0.08876
19	DEC 17	0.16065	0.15	0.21133	0.08866
20	JAN 18	0.19112	0.19	0.25875	0.12124
21	FEB18	0.18478	0.19	0.26084	0.11915
22	MAR 18	0.16838	0.19	0.25899	0.12100
23	APR 18	0.20689	0.19	0.25911	0.12088
24	MAY 18	0.18394	0.19	0.25806	0.12193
25	JUN 18	0.20875	0.19	0.25829	0.12170
26	JULY 18	0.19869	0.19	0.25716	0.12283
27	AUG 18	0.16875	0.19	0.25579	0.12420
28	SEP 18	0.19426	0.19	0.25641	0.12358
29	OCT 18	0.20700	0.19	0.25641	0.12358
30	NOV 18	0.18322	0.19	0.25558	0.12441
31	DEC 18	0.20241	0.19	0.25468	0.12531
32	JAN 19	0.24921	0.232	0.30312	0.16087
33	FEB 19	0.22187	0.232	0.30278	0.16121
34	MAR 19	0.21276	0.232	0.30181	0.16218
35	APR 19	0.23795	0.232	0.30149	0.16250
36	MAY 19	0.21884	0.232	0.30181	0.16218
37	JUN 19	0.24770	0.232	0.30149	0.16250
38	JULY 19	0.25688	0.232	0.30202	0.16197
39	AUG 19	0.22590	0.232	0.30149	0.16250
40	SEPT 19	0.22833	0.232	0.30000	0.16392
41	OCT 19	0.23342	0.232	0.29999	0.16402
42	NOV 19	0.24929	0.232	0.29902	0.16497

Table 5.3: P-Chart Data Calculated

VI. DISCUSSION

The figure-3 shows that the At-risk behavior, that is the unsafe acts and the unsafe conditions have been shown to increase rapidly as the program was implemented in year 2017 but there was dip in the same as the organization as a whole was eager to take part in reduction of at-risk behavior and consequently the percentage safe behavior also improved but in the year 2018 there was expansion of operations in Industrial area thus the number of the at-risk behavior also increase due to increase in the number of pool of the employees but on the other hand these values have been fairly constant as the personnel in the safety department has become more experienced and trained for reliable reporting. The number of positive observation have also increased but they have steadily increased and in very less quantity, hence the reason of the percentage safe behavior to be very low in this case. Since the implementation of the program, people have become more observant and aware of the unsafe acts happening around them and aware about the need to report those unsafe acts and conditions. To facilitate this reporting a software named "Genuine" has been introduced since the starting of mid of year 2018, hence the sudden increase in number of observations.

Moreover the management also provides recognition to the employees for providing observations during the monthly celebration ceremony. The p-chart is also plotted figure-5, the behavior based safety process was slightly stable during the during the first year of implementation, mainly due to expanding workforce, seasonal laborers, expansion projects' start-up, employees getting to grips with the new behavior based safety process

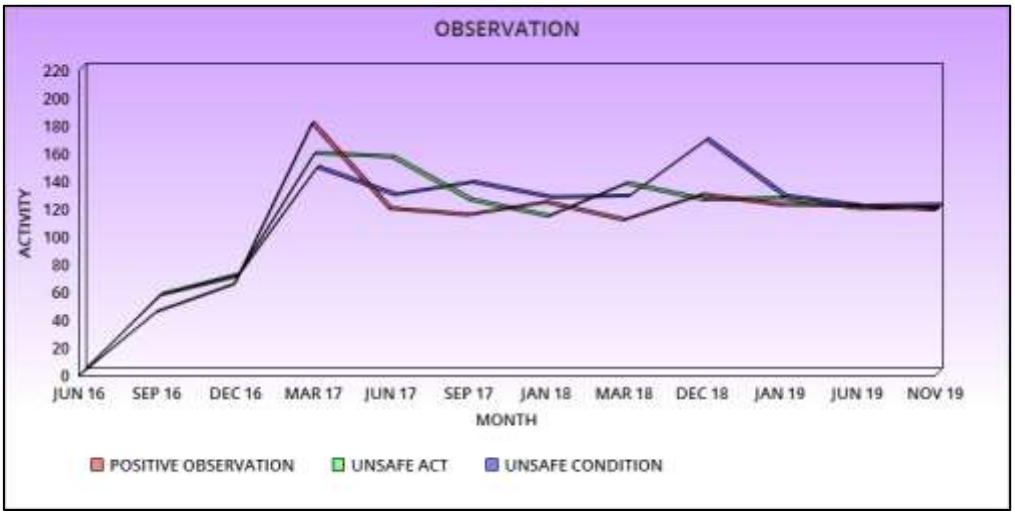


Fig. 3: Trend of the Unsafe Act & Positive Observations

Fig. 4: Percentage of Safe behavior

VII. CONCLUSION

It can be see that the behaviour based safety process for the port is a stable process but the proportion of safe behaviour is low which conforms to the fact that the organisation is growing. Also the management must re-think about the focus of the behaviour based safety program right from the top management to the employees as the perception is more to find the at-risk behaviours rather than focusing on the safe and at-risk behaviours. Moreover the p-charts depict that the process is has stabilized after the initial phase of implementation. The labourers and the employees have become more aware about the behaviour based safety program and more accepting to behaviour based safety process which is reflected in the safety percentage and increase in the positive observations. The management must deploy the method of checking the reliability of the safety supervisors or any safety department personnel and recalibrate from time to time in order to get results with accuracy as much as possible.

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