

# Development of Safety and Productivity Correlation for A Rolling and Wire Drawing Factory

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**Abstract** - The work productivity of workers in a company is affected by several factors, one of which is occupational safety and health program and there is a significant effect of safety and health program on work productivity of workers either simultaneously or partially. A poor safety standard primarily originates from the belief that safety and productivity are mutually exclusive objectives, one eating away the other. But in practice they are correlated. The knowledge of exact nature of dependence of productivity with safety and health in industry is therefore highly significant in the context of production. In this project safety and productivity are the two parameters have been focused and the mutual correlation between the two has been analyzed on the basis of the data obtained from the industries various department of safety and productivity and has been presented in the tabulated form by using the data with respect to safety and productivity. The developed correlation is a functional relation between total factor productivity and safety elements and cost of production. Hence, the developed correlation can be used to predict total factor productivity (TFP) from the knowledge of the values of input safety elements and planned cost of production.

**Keywords**- Safety, Productivity, Correlation & total factor productivity..

## I. INTRODUCTION

Whether your work environment is an office or an industrial facility, reducing downtime is the key to maintaining productivity. A factory, on the other hand, would rely on having machines that run at peak efficiency. In either setting, employees are necessary to maintain optimal productivity [1]. Because businesses rely on employees in this way, injuries will lead to lost productivity in any workplace. Businesses that cut corners to save time and speed up production can often seem productive and profitable. In the long term, these environments can also be unsafe, leading to increased downtime. While safety programs often require an initial investment, they also have a positive impact on employee health. Because healthy employees are more reliable and productive, they're also good for the bottom line. A key aspect of finding a balance between productivity and safety is with the enforcement of safety culture. A study by Lockheed Martin of their Paducah Plant found that by developing a safety culture, they were able to increase employee productivity by 24% and reduce factory costs by 20%. Safe working conditions often go hand in hand with ideal operational conditions. With safeguards in place, employees can focus on their work, instead of the dangers in their workplace. Safety in the workplace is productive in other ways, too. Employees who take personal accountability in their safety are more likely to be engaged and happy at work. Many studies have shown a link between happiness at work and employee

productivity. To finish bringing things full circle, engaged employees are also more likely to be safe at work [2].

## II. INCREASE PRODUCTIVITY BY THE SAFETY

The workers were sufficiently aware of how human factors and safety rules influence their performance and acknowledged that supervisors had adequately communicated such topics. Safety and productivity seemed equally balanced across the sample [3].

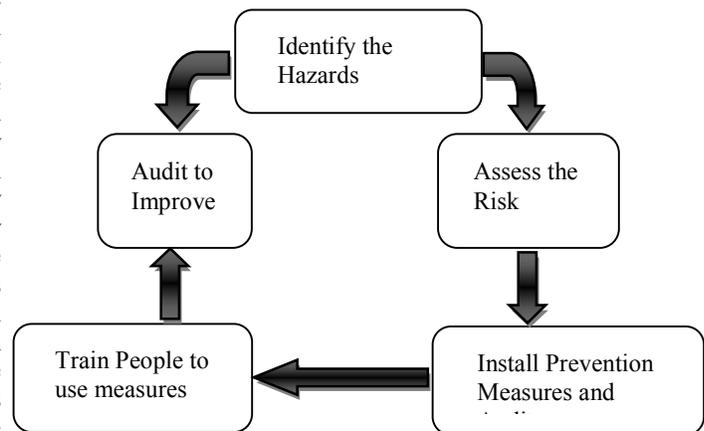


Fig.1. Close loop Safe & Healthy Working System.

A preference for the former over the latter was associated with a higher awareness about human factors and safety

rules, but not linked with safety communication. The size of the facility and the length and type of employment were occasionally correlated with responses to some communication and human factors topics and the equilibrium between productivity and safety [4].

### III. PROBLEM FORMULATION

The problem here is all companies want production with safety and both are two different aspects of organisation planning. Every company wants higher production rate and at the same time wants that their employees to be safe. This makes a gap between the production and safety, because every company wants production and safety but always invests more in production as compared to safety. However due to enforcement of legal laws makes them to have all safety aspects and legalisation but still there are always gap between these two. Hence here the problem is company wants both production and safety at the same time. However these two are different aspects of organisation and can fulfil the requirements when both have equal importance [5].

### IV. PROPOSED METHODOLOGY PEARSON CORRELATION COEFFICIENT

Pearson's correlation coefficient is the covariance of the two variables divided by the product of their standard deviations. The form of the definition involves a "product moment", that is, the mean (the first moment about the origin) of the product of the mean-adjusted random variables; hence the modifier product-moment in the name. In statistics, the Pearson correlation coefficient, also referred to as Pearson's  $r$ , the Pearson product-moment correlation coefficient (PPMCC) or the bivariate correlation, is a measure of the linear correlation between two variables  $X$  and  $Y$ . Owing to the Cauchy-Schwarz inequality it has a value between  $+1$  and  $-1$ , where  $1$  is total positive linear correlation,  $0$  is no linear correlation, and  $-1$  is total negative linear correlation. It is widely used in the sciences. It was developed by Karl Pearson from a related idea introduced by Francis Galton in the 1880s [6].

We have analysis of data for much accident annually for rolling mill and drawing industries and describe for table below for most accident injuries for minor and major causes of work for workers in rolling mill and drawing industries and factory to effect for production, productivity and workers.

As the data clearly shows that the accidents and fatalities are gradually decreasing that means increase in the rate of safety of the steel industries, the above data is showing good rate of safety in steel industries as the productions increases gradually but there is decrease in the fatality and accidents. On the basis of the data obtained from the industry. An Analysis has been made on the productions per tones/ per year with the major, minor and fatalities in or between years and has been presented below:

Table1. Analysis for Annual Accident with the type of injuries and cause of accidents.

S.No	Type of Accidents	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18
1	Slip Fall	8	11	20	13	6	10	12	11	12	10	8	7
2	Material Handling	15	9	8	7	6	--	--	9	9	8	6	5
3	Hit by moving Object	11	5	5	3	7	4	3	5	6	4	4	3
4	Hit by falling objects	8	5	5	3	7	4	3	3	5	6	3	4
5	Electrical	6	4	3	--	2	--	2	4	5	3	4	2
6	Hot metal Burns	5	2	3	5	1	1	2	3	2	1	0	1
7	Burns due to other hot objects	12	8	2	4	4	1	19	8	7	4	6	4
8	Pressed between objects	12	6	3	8	6	8	5	7	8	5	4	3
9	Struck Against Objects	1	1	Nil	Nil	Nil	1	--	1	1	2	0	1
10	Miscellaneous	5	9	3	4	2	--	--	5	6	4	4	4
Sum		80	60	52	47	41	29	46	56	61	47	39	34

Table2. Analysis has been made on the productions in tones between three years (from 2003 to 2018) with the number of major, minor and fatalities accidents.

S. No.	Year	Production	Major Injuries	Minor Injuries	Fatality	Total
1	2003-2006	10000	10	40	5	55
2	2006-2009	12000	6	29	3	48
3	2009-2012	15000	5	25	1	31
4	2012-2015	17500	3	21	1	25
5	2015-2018	22000	1	12	0	13

The following formula is used for calculation:-

$$r = \frac{n\sum uv - (\sum u)(\sum v)}{\sqrt{n\sum u^2 - (\sum u)^2} \sqrt{n\sum v^2 - (\sum v)^2}}$$

Where,  $u = \frac{x-a}{1000}$

$y = y-b$

$r$  = Pearson  $r$  correlation coefficient

$n$  = number of value in each data set

$\sum u$  = sum of  $u$  scores

$\sum v$  = sum of  $v$  scores

$\sum uv$  = sum of the products of paired scores

$\sum u^2$  = sum of squared  $u$  scores

$\sum v^2$  = sum of squared  $v$  scores

$$r = \frac{5x(-312) - (1.5)x(17)}{\sqrt{5x(89.25) - (1.5)^2} \sqrt{5x(1225) - (17)^2}}$$

$$r = \frac{5x(-312) - (1.5)x(17)}{\sqrt{5x(89.25) - 2.25} \sqrt{5x(1225) - 289}}$$

$$r = \frac{-1560 - 25.5}{\sqrt{444} \times \sqrt{5836}}$$

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$$r = \frac{21.0713 \times 76.393}{-1585.5}$$

$$r = \frac{-1585.5}{1609.83}$$

$$r = -0.984$$

The main result of a correlation coefficient (or "r") is negative or inverse correlation. If we increase or decrease one variable Accident in a corresponding decrease or increase in the production (other variable). Hence, if decrease the accident rate we increase the production and vice versa.

Table3. Calculation the above the data analysis table:

n	Annual Production (x)	Accident in year (y)	$u = \frac{(x-a)}{1000}$	$v = (y-b)$	uv	$u^2$	$v^2$
1	10000	55	-5	24	-120	25	576
2	12000	48	-3	17	-51	9	289
3	15000	31	0	0	0	0	0
4	17500	25	2.5	-6	-15	6.25	36
5	22000	13	7	-18	-126	49	324
Sum			1.5	17	-312	89.25	1225

## V. WIRE ROLLING INDUSTRIAL MATERIAL

At the time of the research steel rolling mills with them located in the industrial area. during the research work only three of the rolling mills were fully operational due to a serious drought that affected to the industries for production processes. The three steel rolling mills in operation at the time were a dp wires limited, the dp mills limited the actual names of the steel rolling mills have been withheld for confidentiality. the survey was conducted on administrative management and production workers of a dp wires limited to determine the health and

safety awareness on hazardous exposure. their real names are not used for confidentiality purposes. the methodology used for the relation between productivity and safety is done by using the graphical represent to plot the graph. Graph is plotted between production quantities and injuries and between injuries and occupational health and safety. There two graphs shows the types of injuries in a year and injuries occurred in per year production/ productivity.

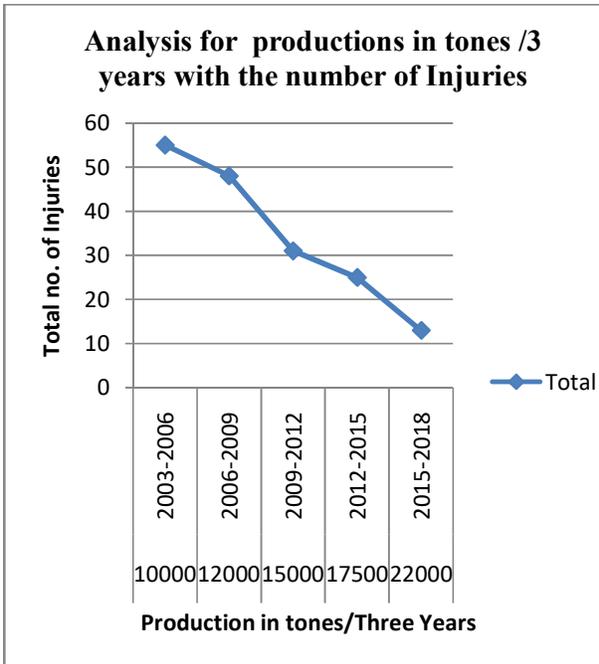


Figure2. Graphical analysis of analysis for productions in tones /3 years with the number of Injuries.

## VI. RESULT OBTAINED AND INTERPRETATION

The final result has been plotted, on the basis of the analysis of all the observation collected data obtained. And the graph is plotted for the Data Analysis as well as for the Occupational Health and Safety with the help of the data above in the tables. The data obtained has been interpreted graphically. The first graph clearly shows about the Data Analysis of the production of the steel and the number of injuries during that amount of production. The second graph shows the occupational disease due to particular job factor causes in the steel plants and industries. The result which has been obtained on the basis of these observations has been interpreted and analysed that by giving more focus on observations parameters of illumination, temperature and noise, production increases and observations parameters decreases year by year. On the basis of interpretation of graph results has been obtained.

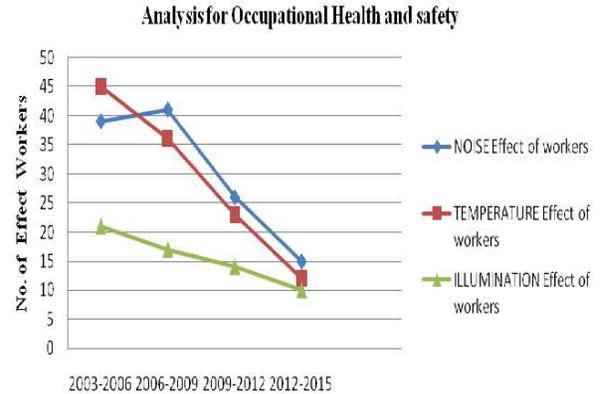


Figure3. the above data analysis for occupational health and safety.

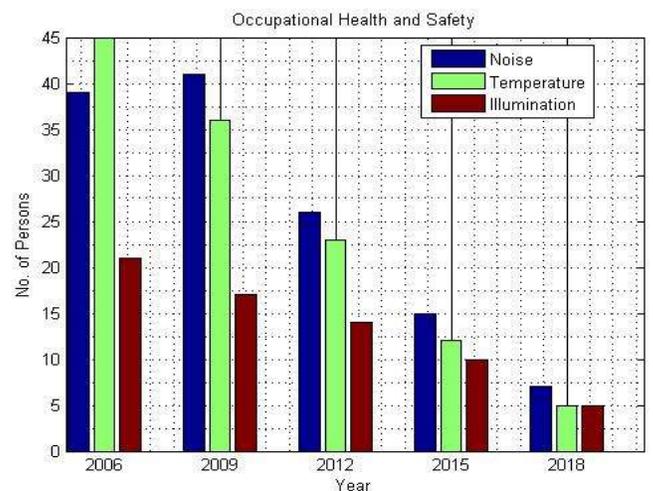


Figure 4. Occupational Health and safety in illumination, Temperature & Noise.

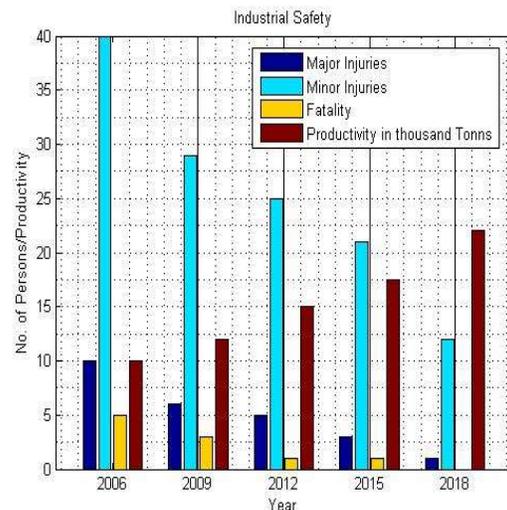


Figure5. Industrial safety in minor, major, or fatality and production.

## VII. OBSERVATION

The observations for the data and result interpretation have been collected from the different departments of the company. The data has been collected from safety department as well as from production department, Occupational health centre. Also the previous year's data collected from the industry including all departments with respect to safety and productivity. The observation has been made after the final collection of data including all years and analysis has been made from the data collected from the industry of safety and productivity, it has been observed that the number of accidents in the previous years is more as compared to the coming years. Different observations of accidents like slip, trip, fall hazard, material handling, hit by objects, hot metal burns, struck, illumination, temperature and noise has been observed during the analysis of study. Also the production of steels and alloy steels has been observed during the years. Out of these the most which has impact on the production is temperature, noise and illumination. So basically focused has been given on these observations with respect to production.

## VIII. RECOMMENDATIONS AND FUTURE SCOPE

Production and safety play a significance role in leads to the smooth running of an organization. To run an organization both, have to run in proper balance. From the results it is observed that with passage of the time production increases and at the same time incidents reduces. The most important elements of safety like safety training, Risk assessment, Hazard analysis, continuous monitoring plays a vital role in achieving the reduced accidents rates with high productivity. So the most important role in achieving that is to maintain all the safety elements in workplace. By enforcing more safety elements, training, analysis, corrective actions, PDCA we can achieve better results. Management should give priority to both productivity and safety then an organization can be called a successful organization. So it is recommends that the in future that these parameters should have been given preference by company for the betterment and smooth running of the company. In future including these parameters more parameters have to be included for making more incident and accident free company. However it is recommend that company should maintain the basic parameters of safety to make the industry accident free. For this not only preference given to production but also to safety.

## IX. CONCLUSION

Production and safety plays a significance role in leads to the smooth running of an organization. To run an organization both have to run in proper balance. From the results it is observed that with passage of the time production increases and at the same time incidents

reduces. The most important elements of safety like safety training, Risk assessment, Hazard analysis, continuous monitoring plays a vital role in achieving the reduced accidents rates with high productivity. So the most important role in achieving these is to maintain all the safety elements in workplace. By enforcing more safety elements, training, analysis, corrective actions, PDCA we can achieve better results. Management should give priority to both productivity and safety then an organization can be called a successful organization.

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