

Implementation of Safety Techniques in the Manufacturing Industry



Sushil Kumar, Robin Thakur, Bhaskar Goel, Raj Kumar, Amar Raj Singh Suri

Abstract: Nowadays industries want to grow day by day, by fulfilling the demands and satisfying the customers according to their needs and expectations. If there is any deficiency in the industry, it should be eliminated within time to compete in the market, for this they can use new techniques to solve the problems of industry and by giving a safe working environment to their workers. The aim of this study is to reduce or eliminate accidents during manufacturing processes in the industry. Generally, it is noticed that the organization facing so many issues in its production due to the lack of proper safety measures. To eliminate the accidents, Root Cause Analysis (RCA) and Pareto technique are applied to find out the main causes of accidents. By the implementation of corrective action, the production of industry is enhanced by reducing accidents from 35% to 8.3%.

Keywords: Root Cause Analysis; Pareto; Industrial Safety.

Nomenclature:

HAZOP	Hazard and Operability
HzM2S	Two-Stage Multilevel Hazop
OHS	Occupational Health & Safety
NMS	Near miss Management systems
ZAV	Zero Accident Vision
ITER RH	International Thermonuclear Experimental Reactor Remote Handling
CAMD	Computer-Aided Molecular Design
ZAV	Zero Accident Vision
RAC	Root Cause Analysis

I. INTRODUCTION

Accidents occur in daily life, causing loss of life and property. Accidents are very common in our daily lives. Air, railways, roads and industrial accidents are sometimes very fatal.

Accidents can be reduced or controlled, but cannot be eliminated. Accidents affect the person and his family life. Different jobs have different accident rates. In the case of road accidents, the rates of accidents are higher on busy roads compared to crowd-free roads. Accidents in industries are called industrial accidents.

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Those accidents are common because of the lack of knowledge on the part of the components and the machinery, or the workers. Proper caution can eliminate or reduce accidents.

There are always some sources for the event of accidents. There are always possibilities of accidents while working on machines and equipment, all operations that are done in industries, where the probability of accident increases. Proper training and information is given to the employees about the dangers of accidents. Security management has the responsibility of the organization to control the health and safety hazards of its employees by using efficient and scheduled activities. The main purpose of security management is to intervene in the process of accidents, which causes accidents. It includes active gratitude for detectable and undesirable hazards. Security management should ensure that the safety activities were properly employed to systematize and to implement successfully.

Vaidhyathan and Venkatasubramanian[1] studied that, semi-quantitative separating strategy was effectively tried on the investigation of ethylene plant HAZOP on an industrial scale, for which a critical decrease in the number of results was acquired in carefully quantitative examination. This methodology has been appeared to kill just unreasonable outcomes while having the option to distinguish the causes and results that were found by the HAZOP group.

Mushtaq and Chung [2] studied that the issues related to batch process security which describes a method, which splits a composite design in small part strictly for sequential study. A computer-assisted tool is useful to guide and record the test.

Cagno et al.[3] found in his study that HzM2S functionality offers a possible alteration, each choice can abuse a complete and increasingly definite information base, which can demonstrate at what level intercession is fundamental; simultaneously, the record can be taken from existing physical and venture constraints and committed assets can be overseen in the most ideal manner to decrease the normal hazard.

Brun[4] in his study caters to the aim of building a creative picture of OHS in small production industries of Quebec. The study was in line with the responses received from the expert's managers. The impact of the representatives to accuse mishap issues is to abstain from scrutinizing the company's administration and work association.

Labovský et al. [5] demonstrate a new approach to distinguish the risk. The premise of this technique is the incorporation of programming devices, for the most part, intended for the wellbeing investigation of concoction reactors in the HAZOP study.

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This addition is useful for distinguishing the outcomes for some deviation and recommendations for restorative activities.

Zhao et al.[6] considered that Petro HAZOP can give modern act of HAZOP in China and can add to the counteraction of misfortune in the biggest creating nation, where synthetic mishaps are making a genuine danger its fast development.

Liin et al. [7]using a target based methodology for HAZOP investigation has been presented, which enables show that the companies adopting SMS display higher performance than all the identified subjects.

Dunjó et al. [9] analyzed that Process Hazard Analysis (PHA) technique is a part of hazard and operability, which is utilized all-inclusive for examining the hazard of an association as well as its probability of issues, by researching the assets of a few gathering from plan conditions.

M. N. Vinodkumar and M. Bhasi [10] directed an examination to give solid experimental help to the hypothetical model, which are firmly identified with the segments of predecessors, determiners and security execution. The assessed limit of six securities the executives rehearses is shown on security information, safety inspiration, safety consistency, and security association. The aftereffects of this investigation additionally distinguish the systems by which they can improve the safety of the working environment.

Liin et al. [11] applied an approach to deal with diminish the work engaged with HAZOP of the plant by separating the plant with practical lines and investigating just one size node. It promises development for a methodical investigation of the work process associated with the HAZOP study, which empowers the structure of skilled equipment to help significant HAZOP studies to improve safety-critical functions in the industry.

Espen et al. [12] presents the statistics from the hazard level venture in the Norwegian business about the sheltered condition and undesirable things and discusses the significance of deepwater penetrating. The significant focal point of the danger pointer in the risk level project is on the assembling system, any place only a set number of event meters and impediment markers are identified with versatile drilling units.

Badri et al.[13] concentrated on the construction industry, the degree to which OHS hazards are considered in venture the executives and industrial security practices. They were demonstrating the need to overcome the risks of the OHS project and to make adequate funding plans to the project risk management team if the organization wants to avoid hazards and disadvantages that threaten them.

Veltri et al.[14] examined the security practices and results in a broad authoritative setting for business activities. The investigation shows that there is an open door for associations to improve wellbeing and operational outcomes at the same time. At the point when operational supervisors can have everyday power over security the board, security staffs are required to give important exhortation and advising to operational directors on the wellbeing rehearses important to ensure laborers and increment operational outcomes.

Gnoni et al.[15] studied that NMS for an assembling organization is a mind-boggling issue in light of the fact that numerous variables must be assessed. The expert

chemical engineers to make significant commitments in the HAZOP study. It advances improvement for an increasingly methodical investigation of the work process associated with HAZOP examines, which empowers the plan of gifted gear to help significant HAZOP study activities in the business.

Bottani et al. [8] assessed through empirical investigations, even though the performance of non-adopting companies in adopting security management systems (SMS). The results

security of the executives' framework requires various methodologies and skills. The application has become compelling on the grounds that the proposed structure of NMS has been completely actualized in all the firm divisions.

Duisings et al.[16] discussed maintenance processes and gives helpful and significant examination results. Hazards were distinguished and changes were proposed to build up the plan of ITER RH activities, gadgets, and user crossing points. A chosen number of these hazards and plan changes were routed to show the presence of these hazards in the underlying period of these examinations. HAZOP gave the number of building blocks, which included general risks.

Yoon et al. [17] assessed the security and health features of ideal particles produced by the CAMD approach. The reason for this problem is to reduce the pressure of both the soil coefficient of the solvent and the vapor pressure, due to the lack of desired target asset. The current CAMD approach should be changed to remember parts of security and health for the underlying basic leadership process.

Hanim et al. [18] studied the connection between safety and health practices of safe workplaces. The outcomes show that every one of the factors is dependable and legitimate. The outcomes show that every autonomous variable has a positive association with damage to the executives. Of the five securities and health, practices will give a huge effect and show that representatives use detailing insurance on their sheltered workplace for their working environment.

Okun et al. [19] presented a hypothetical structure in the Health Trust Model to furnish youthful laborers with fundamental working environment safety and health information and aptitudes. To ensure the adolescent at work, there is a coordinated technique that includes ecological change, law, and implementation, yet in addition to instruction and preparation. The principal working environment security and wellbeing abilities can assume a significant job in shielding young employees from damage or disease.

K. Jilcha and D. Kitaw [20] did the examination to see the effect of modern business security and health advancement on maintainable improvement. In logical inconsistency, regardless of whether there is no such association in the organizations, yet over 84% of respondents accept that working environment advancement is significant for the decrease of injury, cost decrease, practical improvement, and top administration duties and gathering exchanges.

S. F. M. Twaalfhoven and W. J. Kortleven [21] conducted a study on road safety and occupational safety & health.

ZAV's claim to renown concentrated on a framework hypothesis to recognize the main drivers of dangerous conditions, instead of individual mistakes and imperfections.

However, the worker's conduct is by all accounts a significant objective for Tata's security strategy and numerous administrators demand to refuse unsafe conduct. This correctional tendency appears to be in part overpowering and simultaneously can stop several desires of eliminating all accidents.

Deniz [22] carried out the study to add to alleged security to improve the personal satisfaction and health of the community. In this investigation, the impact of the dread of wrongdoing on the way of life of the old has been analyzed for reexamination of age contrasts in supposed wellbeing and security. To do this, orderly observation and

face to face studies were led to conducted community health and security issues to make lasting urban areas and communities.

Hoła et al. [23] exhibited the consequences of research on the reasons for mishaps at the workplace that include framework. The reason for the detection and characterization of the reasons for mishaps were post mishap conventions drawn up by labor inspector. The examination included mishaps that happened in Lower Silesia in the years 2008-2015. In view of the examination of 41 mishaps including the platform, their causes were resolved. They were then ordered into the accompanying 3 groups of causes: specialized, executive and human. Examination of Pareto-Lorenz was applied so as to decide the most widely recognized causes in each group.

Table- 1: Various investigations on industrial safety

Investigator	Parameter	Type of Industry	Findings	Techniques
Mushtaq and Chung [2]	To examine the operational phase of the chemical industry like charge, reaction, and discharge.	Chemical plant	An augmentation of this philosophy has been created for use in the protected structure of procedures in pipeless plants.	Modified HAZOP
Cagno et al. [3]	To control the usual hazards of plant expenses.	Engineering and Contracting company	This permits a decrease in execution costs, legitimizing the utilization of the system both in creative or basic cases.	Two-Stage Multilevel Hazop (HzM2S)
Zhao et al.[6]	To develop the knowledgeability of HAZOP professional methods.	Chemical Process Industry	The proposed HAZOP master framework Petro-HAZOP encourages "schedule" investigation yet in addition "non-schedule" examination because of its learning capacity by which the HAZOP investigation quality can be consistently improved during training.	Petro HAZOP
Gnoni et al.[15]	The aim of a useful NMS is to identify indications from the working area so that more effective pre-detection policies can be implemented.	Chemical industry	NMS was utilized to execute gaining from experience ideas in word related security management. The firm has recently gotten empowering results for supporting the ceaseless improvement process for its business security management structure.	NMS (Near-miss management systems)
K. Jilcha and D. Kitaw[20]	To improve workplace safety and health.	All types of industries.	This examination found that work environment safety and physical condition advancements bring practical development through healthy citizens, more secure work environments, decreasing the expense of mishaps, controlled conditions, control workplace mishaps, and improved working environment safety facts.	OHS

II. METHODOLOGY

The examination sorted out based on information on accidents in the production industry Shivalik Bimetals Control Pvt. Ltd. situated at Solan (Himachal Pradesh). The resource of data about the way of mishaps is followed by the labor inspectors. For the purpose of organized investigation, the meaning of the reason for a mishap is the insufficiencies and inconsistencies identified with the substance operators the general association of work and the work environment and representatives and their unfair behavior. For the data collection of industrial hazards, the brainstorming is done with different people (Managers, Supervisors, and Workers, etc.) of different departments. To identify the most important reasons for accidents, the analysis of the Pareto is implemented. The Pareto tools helped to find out the main causes of accidents. After identification of the critical factors (like inappropriate production planning, over fabrication, cutting and punching process, etc.) modified action (like sensors are used in punching machines, production is planned according to priority wise, training is

given to the workers, etc.) takes to reduce all these factors of accidents in the industry.

III. RESULTS AND THEIR ANALYSIS

A. Pareto Chart and Root cause analysis

The Pareto principle is otherwise called the 80/20 rule; it is a hypothesis that 80% of the profitability from a given association is determined by 20% of the input. The Pareto diagram helps us to distinguish defects and their causes.

Root cause analysis (RCA) is a systematic procedure for an approach to identify and respond to root causes of problems or events. So we used the Pareto chart and Root Cause Analysis (RCA) to find out the critical factors in the industry.

The critical factors are found out by applying RCA, all the factors are mentioned in the fishbone diagram which is responsible for the accidents in the industry, as shown in Fig. 1.

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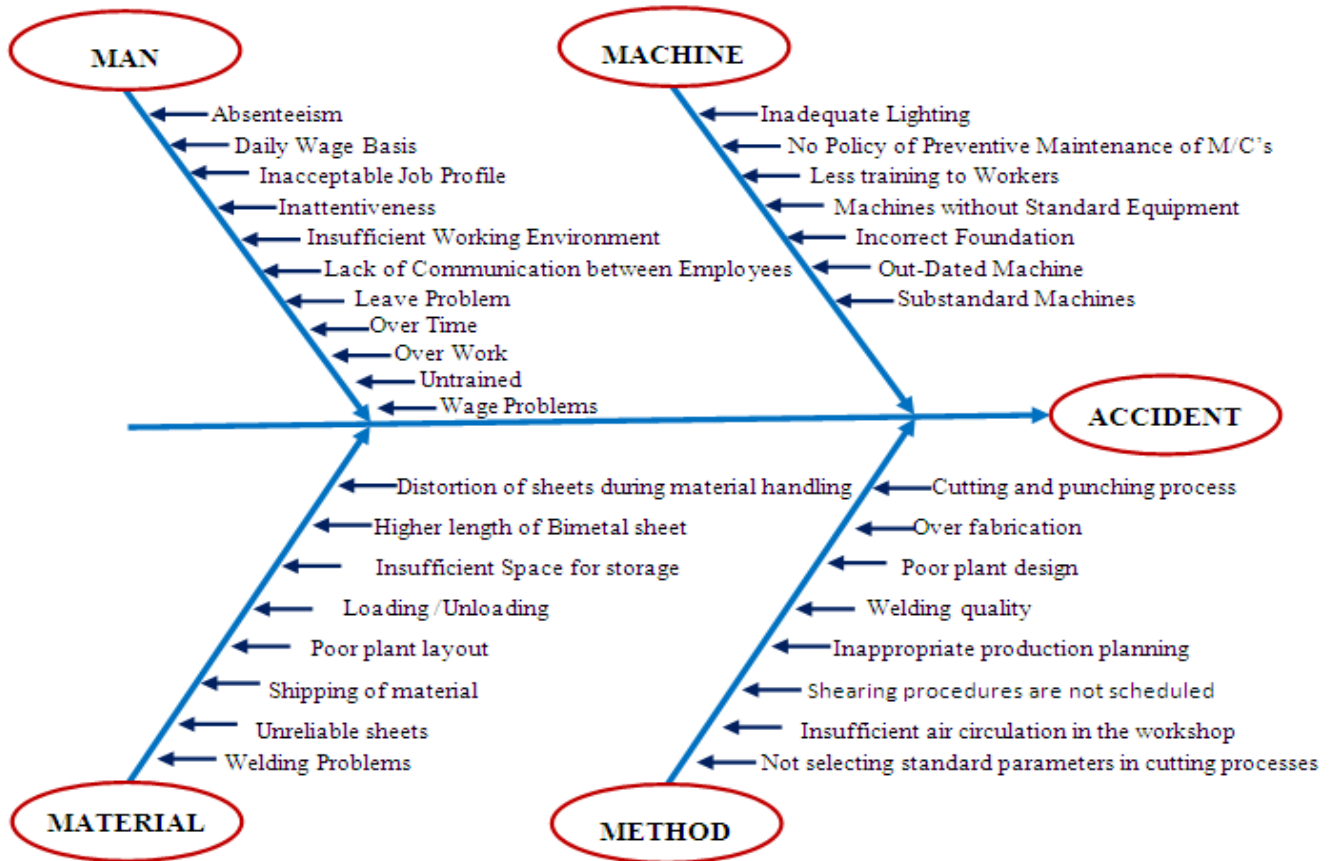


Fig.1. Fishbone diagram for all factors which are responsible for accidents

For the data collection of critical factors, the brainstorming is done with different people from different departments of the industry. With the help of interviews, brainstorming and questionnaires the data collected for Pareto analysis to identify the critical factors. After brainstorming the various factors like higher length of the bimetal sheet, inappropriate production planning, over fabrication, untrained workers, cutting and punching process were found out the number of average 37.69 as shown in

Table 2. Similarly, all main factors which are responsible for the minor accidents in the production industry are categorized in the table. After that, we find the cumulative sum of these accident data by adding the average accident factors one by one. The total of average accidents is 60.715. Then we calculate the percentage of cumulative accidents which is shown in Table 2 by applying the following formula;

$$\text{Percentage of Cumulative Accidents} = \frac{\text{Average Accidents}}{\text{Total of Average Accidents}} \times 100 \quad (1)$$

Table- 2: Cumulative sum and percentage of critical factors.

S. No.	Accident Factors	Average Accidents	Cumulative Accidents	Percentage Cumulative Accidents
1	Cutting and punching process, Higher length of bimetal sheet, Inappropriate production planning, Over fabrication Untrained workers	37.69	37.69	62.08%
2	Distortion of sheets during material handling, No policy of preventive maintenance of M/C's Out-Dated Machine	13.36	51.05	84.08%
3	Insufficient space for storage, Poor plant design Shipping of material	6.412	57.462	94.64%
4	Absenteeism, Substandard machines Unreliable sheets	3.253	60.715	100%

Pareto technique helps to find out the main sources of the accidents and all the primary sources are recorded and recognized. Fig. 2 shows the critical factors of the accidents which are expressed through the Pareto chart. In this chart the critical factors are represented by a bar, higher the bar length, higher the critical factor. The cumulative percentages appear by the Pareto chart suggesting that the primary cause of accidents is the largest bar. This particular cause contributes 20% of all accidents

and, as such, can be associated with 80% of the harm to the economy. The reason falls into this category of factors requiring the most urgent action. Once the particular causes are eliminated, the accident rate should decline significantly. In Fig. 2 the bigger bar shows the major critical factors which are responsible for the severe accidents and the other smaller bars show the least severe accidents. In the graph, the red line shows the cumulative percentage of the accidents that happened in the industry.

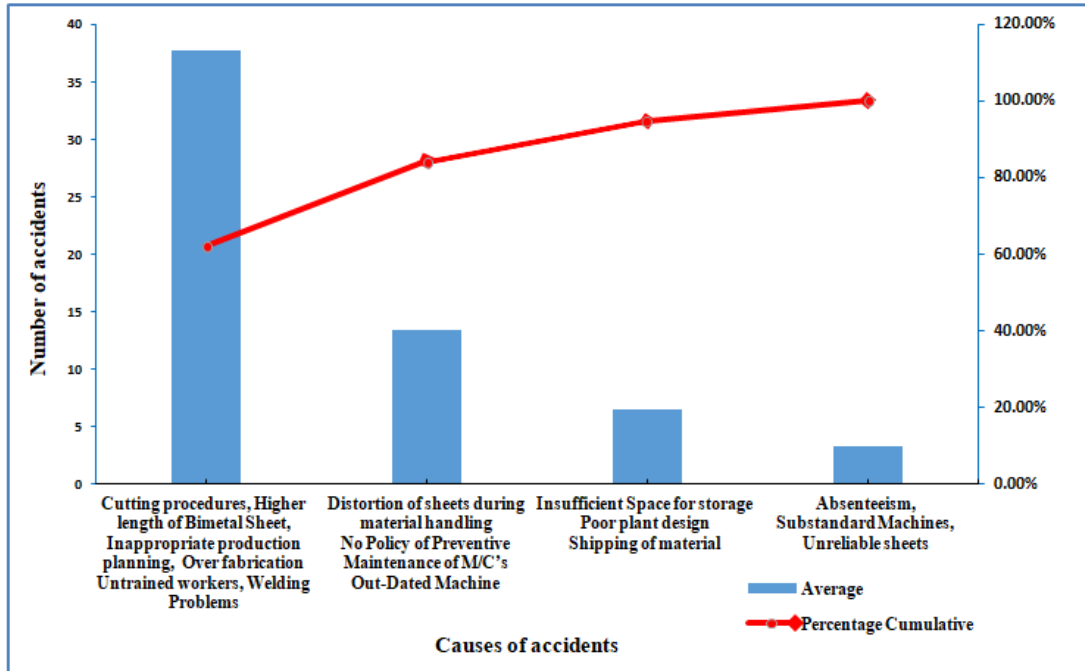


Fig.2. The Pareto chart showing the causes of accidents in the industry.

B. Modified Action Taken

The modified actions are taken in the industry which is shown in Table 3. The training is provided to all the workers for at least two weeks in the industry. After that, the tests are conducted and certificates given to those workers who clear the test. Then only those workers are allowed to do the specific operations that have performed well. After that, the works are distributed to the employees according to their skills. The skills improvement training helps the company and production quality and safety of the human, machine, and products. Due to the accidents, the workers are injured and the production stopped due to which the company goes into a loss. After the training and motivational lectures, the accidents are reduced in the industry. In the case of the cutting and punching process, most of the accidents

happened. In these processes, most of the workers can lose their fingers. Due to that, the workers disabled to do the work. The company gives reimbursement to those workers. The company goes on loss due to these kinds of accidents and also the production rate decreased. The sensors are installed in the cutting and punching machines. Due to those sensors, the accidents are reduced. Overproduction is simplified to priority wise like that which product is to be delivered first, the priority is given to that product. The overproduction is minimized and the chances of accidents also reduced in the industry. The production planning rescheduled so that it can be improved, and the accident rate reduced.

Table- 3: Modified Actions Taken

S. No.	Critical Factors	Before Modification	Corrective Action Taken
1.	Cutting or Punching Process	No Sensor, Old Cutting machines	Sensors are used in punching machines
2.	Over Fabrication, Inappropriate production planning	No proper production planning was done	Production is planned according to priority wise like that which product is to be delivered first, the priority is given to that product.
3.	Untrained workers	Lack of skills and no training to workers	Training provided to the workers and certificates given according to their skills.

IV. RESULT AND DISCUSSION

Table 4 displays the percentage of reduction in accidents in the industry within a span of five years. The percentages of the accidents are more before the modified action and it gets decreased after taking modified action. Fig. 3 shows the

percentage reduction of accidents in the industry. The graph of accidents falls down continuously, this is good for the industry.

Table- 4: Percentage of Accidents Reduction

S. No.	Month of Production	Number of Workers	Number of Accidents Happened	Percentage of Accidents
1	Jan. to June 2014	176	62.32	35.41%
2	July to Dec. 2014	174	59.30	34.08%
3	Jan. to June 2015	169	58.59	34.67%
4	July to Dec. 2015	177	62.69	35.42%
5	Jan. to June 2016	165	61.03	36.99%
6	July to Dec. 2016	172	60.36	35.09%
7	Jan. to June 2017	165	30.50	18.48%
8	July to Dec. 2017	168	23.20	13.81%
9	Jan. to June 2018	171	16.80	9.82%
10	July to Dec. 2018	165	13.70	8.30%

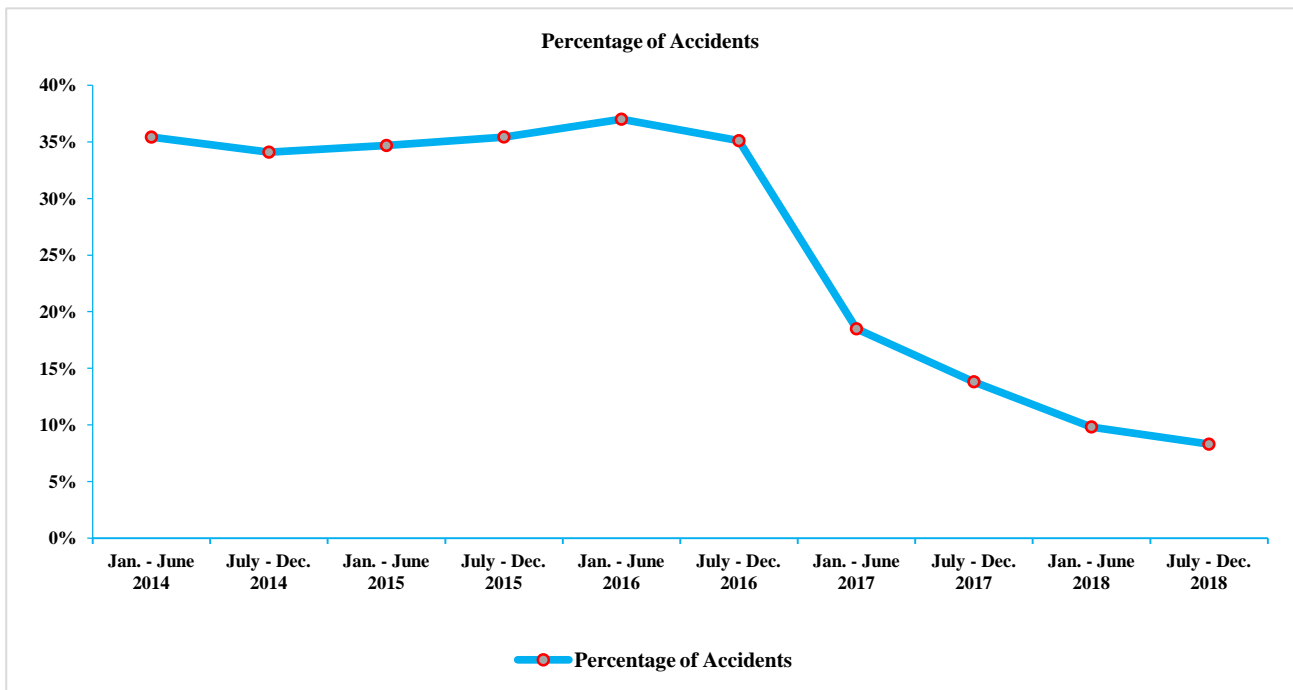


Fig.3. Percentage Reductions in Accidents

The accident reduction rate was very low before the implementation of modified action in 2014. After the implementation of modified action, the accidents reduced continuously as shown in Table 5. Fig. 4 shows the

comparison of average accidents before and after the implementation of the tool. The accident rate decreases continuously after the implementation of the tool

Table- 5: Year Wise Reduction in Accidents

S. No.	Year	Average Accidents in 5 years (%)	Actual Accidents Happened per year (%)	Accidents Reduced per year (%)
1	2014	60.7	57.6	3.10
2	2015		30.5	30.2
3	2016		23.2	37.5
4	2017		16.8	43.9
5	2018		13.7	47.0

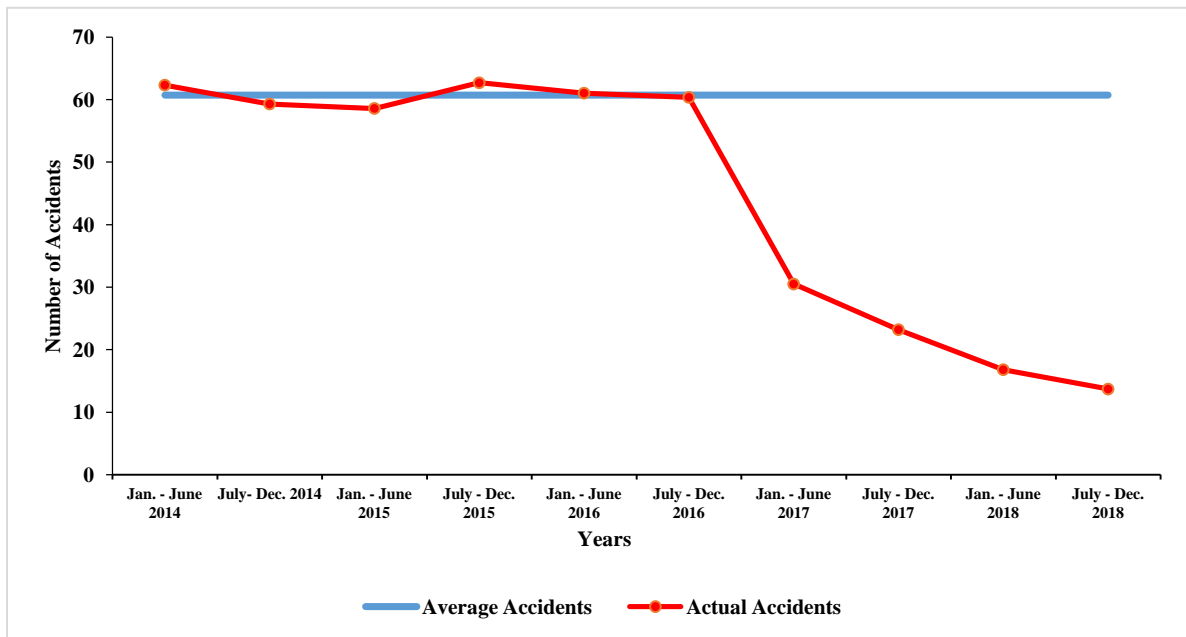


Fig.4. Comparing the Average Accidents

V. CONCLUSION

In this study, we identify that the worker’s lack of proper training is the major cause of accidents in the industry. The Pareto chart analysis has been done in this study as there are measurable considerations. The Pareto tool identifies the root causes of accidents and helps the organization in making decisions regarding the installation of high-tech sensors in the existing machinery and trained the workers accordingly so that they can work efficiently to increase the productivity with minimum losses. The accident percentage reduced from 35% to 8.3% from 2015 to 2018 as shown in Fig. 3. The organization saved an amount of 15.86 Lakhs from the accidental reimbursements in four years along with improved productivity of organization with less risk of accidents. The modified action improves the resources, which leads to continual development in production and goods quality in the organization.

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