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Improvement of Quality Defects and Wastage Control in Mohsin Industry Peshawar through SIX SIGMA

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***Abstract*—**Prior to six Sigma introduction, manufacturing industries used to follow their production procedures without taking an interests in improving the quality of products by meeting customer specifications, which resulted in huge time-consuming and wasteful production. Modern manufacturing industries are trying their best to make their products defects-free, i.e., of good quality,and producing less of waste by improving the processes using various techniques. Six Sigma has made its name in the modern competitive world, competing with each other in the quality field. Six-Sigma is basically a statistical-based processes used to check the deviation of process from standard. Mohsin Matchbox Industry has increased production through six sigma DMAIC methodologies. The DMAIC methodology helped workers do their tasks with less effort by improving the processes. The installation of steel racks helped the targeted industry reduce waste, which increased profit. The rejection rate was reduced to almost 30%. The execution of the six-sigma DMAIC methodology also improved the quality of the product.

***Keywords*—** Quality improvement, process upgrading, six sigma, DMAIC, and waste minimization.

I. Introduction to Six Sigma

Prior to six sigma introduction, manufacturing industries used to follow their production procedures without taking an interests in improving the quality of products by meeting customer specifications, which resulted in huge time-consuming and wasteful production. Modern manufacturing industries are trying their best to make their products defects-free i.e., of good quality, and produce less of waste by improving the processes using various techniques. A good manufacturing firm is one that produces good-quality, defects free products with the least amount of waste.

Six Sigma has made its name in modern competitive world, competing with each other in the quality field. Through the implementation of six-sigma companies, industries saved huge amounts of money by consuming less time in production and ensuring the quality of their products. In the past few years, many organizations have worked hard towards six-sigma implementation.

Six Sigma is basically a statistical-based process used to check the deviation of a process from the standard[1]. Six Sigma is a consistent, flexible process that including all aspects of all elements of a process and uses customer demands to design their process to achieve success by improving quality and saving huge amounts of money by using statistical processes. DMAIC is one of the methodologies of six-sigma.

A. What is DMAIC

DMAIC is basically a data-driven technique that uses data analysed through statistical methods to improve, stabilize and optimize the processes[1]. DMAIC stands for define, measure, analyze, improve and control.The define phase, the main problem is identified and the requirements of the project are listed. In order to define the problem, the processes of the industry must be well understood.The Measure phase includes a full understanding of the process and measuring the current performance[2].The Analyze phase, the data collected in the measure phase is analyzed and problems are identified. In the improvement phase, the performance of the process is improved by eliminating the causes of problems. In the control phase, the processes are controlled for the future[3]. Here, the process is improved and properly maintained in an industry or organization.

B. Introduction to Mohsin Enterprises (PVT) Limited

Our targeted industry was Mohsin Matchbox Industry, which is located in W-21, 22 Industrial Estate, and Hayatabad Peshawar. Industry started its production in 1975 and has been one of the best matchbox sellers in KPK until now. The managing director of industry is Mohsin Aziz, whose collective efforts along with those of the workers result in good-quality manufacturing along with quantity. They have 300 local sellers and also export their products to the Middle East and Africa. They are one of the largest manufacturing industries in Pakistan[4].

The main objective of the industry is to maintain quality standards by producing products according to the requirements of customers. Mohsin Matchbox Industries is working really hard to make their products according to quality standards and is giving a tough time to various competitors by competing in terms of quality and durability.

C. Scope and Expected Outcomes of the Project

In the Mohsin Match Box Industry, the major product is match sticks, which are produced from raw materials such as

wood passing through different machine processes and match boxes. The major problem the industry is facing is related to waste, which result in a decrease in the company's profit. As a result of the wastage of material, millions of rupees are loss to the company. The main focus of our team is to reduce the rejection rate of match boxes that are being printed and the amount of wood that is wasted during the processing of match sticks. So, for this purpose, the chemical composition of the ink will be changed until a good composition is found that will reduce the rejection of match boxes. In this study, we deployed a lean six-sigma-based methodology that is capable of achieving the expected outcomes.

II. LITERATURE REVIEW

A. Six Sigma

The concept of six sigma, first introduced by Motorola in the mid-1980s, is a powerful tool to improve quality defects and minimize waste through a systematic approach. It has been successfully implemented for over 20 years worldwide. It is a methodology of continuous process improvement that is initially introduced in manufacturing processes and implemented in billing, marketing, purchasing, invoicing, hospitality, and customer call answering for customer satisfaction. Six Sigma approaches have a significant impact on profit because they start with customer satisfaction and business strategy and lead towards implementation. After all, the process in which the root causes of the problem are unknown and solved by Six Sigma reduce undesirable variation in the process and focuses on process flow with minimum variation, although, it can solve complex cross-functional problems. Six Sigma works on a methodology known as DMAIC (define,measure,analyze,improve,control) and encourage quality improvement department[5].

Six Sigma is an internal improvement technique that enables organization to produce world-class products and services. To design six sigma, the following point should be kept in mind:

- List the customer's requirements.
- Analysis these requirements and prioritize them.
- Design the product based on those requirements.
- Adjust the production process so deviations from customer requirements are minimized.
- Develop a plan for production control.

DMAIC methodologies are five-phased approaches, which are as follows:

(D) Define: Six Sigma methodology, where leaders are responsible for selecting projects, developing a project charter or statement of work (SOW), and setting initial goals or targets.

(M) Measure: The goal of the measure is to collect and organize the data for the purpose of observation.

(A) Analyze: Identify several possible causes of variation or defects that are affecting the outputs of the process. One of the most important tools used in the analyze step is the cause-and-effect diagram.

(I) Improve: It consists of brainstorming to come up with counter measures and lasting process improvements that address validated root causes.

(C) Control: Implement statistical process control and validate the control system[6].

B. Process Capability

Process capability compares the output of a process to a standard or specification. The ability of the process to meet specifications within the specification limit is assessed through the calculation of one or more capability indices. It provides the opportunity for quality improvement and productivity. A control chart shows the degree of statistical control over the process and may also be used as a basis for estimating μ and σ. A six-sigma process is one that is away from the process mean and whose specification limits are at least 6 standard deviations[7].

The basic capability indices that are commonly used in manufacturing industries are Pp, Ppk, Cp, Cpk, Cpm, and Cpmk.

C. Process Improvement

A variety of approaches have been developed for process improvement when the capability is found to be low. So many methods have been developed for quality improvement and problem solving within the organization. Process improvement uses two techniques: statistical quality control and statistical process control.

Statistical quality control is a technique to analyze improve, and control processes. In statistical quality control, the process is monitored constantly to avoid any type of uncertainty. There are some basic steps which have to be taken by any organization going through statistical quality control. The first step is to measure the process and the variation of the process. Data is collected in measuring step for further use. The second is analyzing the gathered data, which has been measured. In the third phase, variances and defects are eliminated from the process and improved, so that the process is kept under control. In the fourth phase, the process is continuously monitored, to take preventive and corrective actions that are predefined for the process.

Statistical process control is the industry standard methodology for measuring and controlling quality throughput in the manufacturing process. Quality statistics in the form of process measurement or products are obtained at the actual timing of manufacturing processes. This data is then plotted on a graph with determined control limits. Control limits are determined by the potential of the process, whereas specification limits are determined by the customer's requirements. Data that comes within the control limits shows that everything is operating as projected. Any variation within the control limits is probable due to a general cause the natural variation that is predictable as part of the process. If the plotted data is outside of the control limits, this indicates that an assignable cause is likely the source of the product variation,

and something inside the process should be changed to fix the problem before defects take place[8].

III. DEFINE PHASE

A. Problem Statement

In the Mohsin Match Box Industry, the major product is match sticks,which are produced from raw materials such as wood passing through different machine processes and match boxes. The major problem the industry is facing is related to waste, which results in a decrease in the company's profit from Rs. 25 to Rs. 14 crore annually. The rejection rate of match sticks is 34% and that of match boxes is 9.75%.

B. Objectives

- As a result of the wastage of material, millions of rupees are loss to the company.
- The goal of the industry is to achieve the best ink composition, process improvement, and minimize material wastage.
- In this study, we deployed a lean six-sigma-based methodology that is capable of addressing the problem.

C. Project Scope

The main focus of our team is to reduce the rejection rate of match boxes that are being printed and the amount wood that is wasted during the processing of match sticks. So, for this purpose, the chemical composition of the ink will be changed until a good composition is found that will reduce the rejection of match boxes[9].

IV. MEASURE PHASE

A. Data Collection Method

We divided the whole process into many small activities and measured the cycle time of each process in a 40-sample with the help of a stopwatch. Cycle time was measured for each activity, like cutting machines, sheet-making machines box-making machine, packaging machines,and box-filling machines. Waste production was also calculated during the measurement phase. The collected data is further analyzed through graphs.

B. Processing Time of Machines

The total time consumed fromt the beginning to the end of a process or activity is called cycle time. We measured the cycle time of three machines, i.e., cutting, peeling, and sheet-making machines, in seconds with the help of a stopwatch. A worker was observed at each machine; the stop watch was turned on when the worker started performing the activity and turned off when the cycle stopped[10]. The sample size was 40. The processing time was calculated during the working hours of the targeted industry.

The purpose of calculating cycle time was to check which machine takes longer to complete a task during the working hours, which will help to find out graphically which machine produces a larger amount of waste. Then we have to target that specific area to reduce waste.The following table shows the processing time of each machine.

TABLE I. PROCESSING TIME OF MACHINES (SEC)

Cutting machine (sec)	Peeling (sec)	Sheet making machine (sec)
12.15	16.83	18.16
10.52	9.13	16.63
14.04	10.10	12.96
6.45	8.99	23.33
11.19	12.36	20.36
11.67	11.70	22.81
5.29	11.72	18.73
5.35	10.89	11.50
8.23	11.99	16.56
6.97	11.79	16.27
16.52	12.00	20.26
5.55	14.43	18.84
9.02	13.40	17.73
10.04	6.56	15.76
4.26	9.77	21.34
13.07	14.00	27.31
11.89	11.03	16.10
7.07	12.90	13.97
15.13	8.25	13.75
9.35	12.37	15.80

C. Waste Production in the Mohsin Matchbox Industry

The Waste produced by every machine working there was calculated with the help of a weighing machine. Then, after taking the average of all the same machines, a table based on calculations showing waste production was drawn per hour and per shift, as shown below. This data will help us to exactly determine which machine produces a large amount of waste further in the analysis phase[11].

The Waste shown below in the table in terms of per shift was attained by multiplying the waste per hour by 12 hour per shift because the manufacturing industry works 12 hour per shift and produces match sticks two shifts in a day.

TABLE II. WASTE PRODUCED IN MOHSIN MATCH BOX INDUSTRY

Machines	Waste (kg/hr)	Waste (kg/Shift)
Cutting Machine	65	780
Sheet Making Machine	68	816
Chopping Machine	40	480
Dryer Machine	2	24
Powdering Machine	30	360
Simplex Machine	50	600

D. Waste of Wooden Logs in a Trolley

First of all, when the wooden logs, i.e., raw material, come into the trolley,their weight ismeasured with the trolley,and then the waste produced due to those logs is weighed as shown in the table below.

TABLE III. WASTE OF WOODEN LOGS IN A TROLLEY

S.no	Wooden logs in trolley (kg)	Waste (kg)
1	255	10
2	230	15
3	310	18
4	345	15
5	325	10
6	235	15
7	265	15
8	280	25
9	270	10
10	235	15

E. Spindles Weight in Grams

The following table shows the weight of spindles in grams which is obtained by subtracting the weight of an empty box from a filled box of match sticks[12]. The targeted industry produces four types of matchboxes according to their different sizes, i.e., Classic. Slim. Regular and large matchboxes weights are shown below.

TABLE IV. SPINDLES WEIGHT IN GRAMS

Type of Boxes Produced	Empty Boxes	Filled Boxes	Spindles Weight
Classic	0.004 g	0.008 g	0.004 g
Slim	0.002 g	0.004 g	0.002 g
Regular	0.002 g	0.006 g	0.004 g
Large	0.004 g	0.010 g	0.006 g

F. Rejected number of Boxes

We also calculated data about the rejected boxes per machine as well as for twenty-five machines, as shown below in the table. Here rejection means the spindles that fall down during the process from every machine, i.e., from the chopping machine to the box filling machine, and those spindles were converted into matchboxes of every size to check how many boxes get rejected during falling spindles.

TABLE V. REJECTED NUMBERS OF BOXES

No. of Boxes wasted	Per Machine rejected Matchbox	For 25 Machines
Classic	8	200
Slim	2	50
Regular	8	200
Large	12	300

V. ANALYZE PHASE

A. Applying ANOVA to the Defects in Finished Match Boxes

To check the variation among different compositions, an ANOVA is used[13]. The ignition of match sticks depends on the printed chemicals on the match box, so the composition at which the chemicals are mixed in weight ratios will affect the ignition of the match sticks. The team concluded to apply a one-way ANOVA to the different compositions of the chemicals.

B. One-way ANOVA

To study the effect of composition, twenty different compositions were tested. The compositions include ingredients and the ratios in which they are mixed.

TABLE VI. ONE- WAY ANOVA FOR TWENTY COMPOSITIONS

S.no	Red-phosphorus	Varnish	Powdered glass	Kerosene oil	Hard dryer	Others
S1	48	10	13	13	5	11
S2	48	12	14	13	5	8
S3	48	13	13	13	5	8
S4	50	11	13	12	5	9
S5	47	13	13	13	5	9
S6	44	14	14	13	6	9
S7	50	12	12	12	5	9
S8	42	16	15	13	5	9
S9	41	16	16	13	5	9
S10	52	12	12	13	5	6
S11	49	14	11	13	5	8
S12	47	12	13	14	5	9
S13	43	14	14	13	6	10
S14	49	13	12	13	5	8
S15	41	16	15	14	5	9
S16	46	14	13	13	5	9
S17	45	15	14	13	5	8
S18	43	14	16	13	5	9
S19	49	13	12	13	5	8
S20	44	16	14	13	5	8

The compositions were tested at twenty different levels (S1, S2, S3, and S20), with three different samples at each level. A one-way ANOVA method for P = 0.05 with twenty levels and three replications is selected to find out whether the mean igniting units of matches are the same or not. From the result of a one-way ANOVA, the best composition with a greater mean can be identified. The response variable is the igniting units, and the factors are the different compositions. The sixty runs (twenty levels with three replications) were completely randomized.

a = 20 levels

n = 3 replications

Response = igniting units

TABLE VII. NUMBER OF REPLICATIONS FOR TWENTY COMPOSITIONS

	Replications		
Compositions	**1**	**2**	**3**
1	90	93	89
2	99	97	88
3	91	93	89
4	98	98	99
5	93	95	90
6	92	90	85
7	99	99	98
8	86	85	91
9	80	76	88
10	90	92	93
11	96	95	94
12	93	87	88
13	80	86	79
14	87	85	90
15	80	84	76
16	91	88	92
17	85	89	83
18	94	81	85
19	96	96	95
20	95	88	94

C. Hypothesis Testing

Here are two hypothesis, null hypothesis and the alternate hypothesis. A null hypothesis should be rejected if an alternative hypothesis is true; otherwise, it is believed[14]. The null, hypothesis and alternative hypothesis for the compositions are:

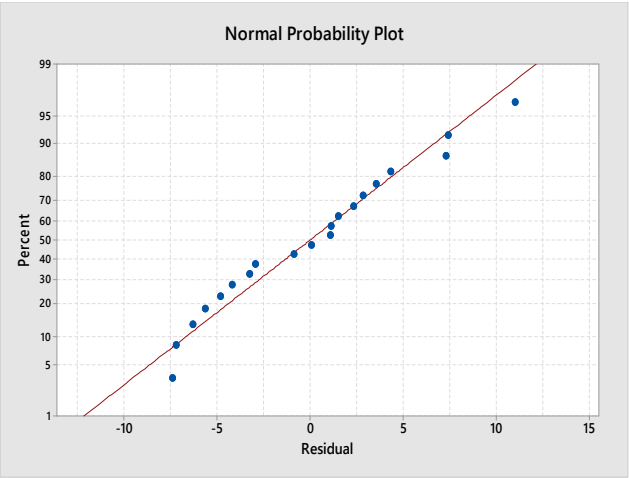
H0: All compositions will result in equal mean units.

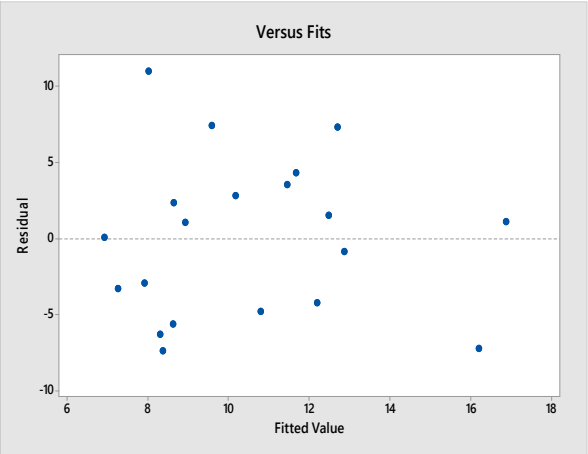
$$\mu 1 = \mu 2 = \mu 3 \ldots\ldots = \mu 20$$

H1: At least one which means different from other.

D. Minitab Results and Graphs Interpretation

Residual plots for S1-S20





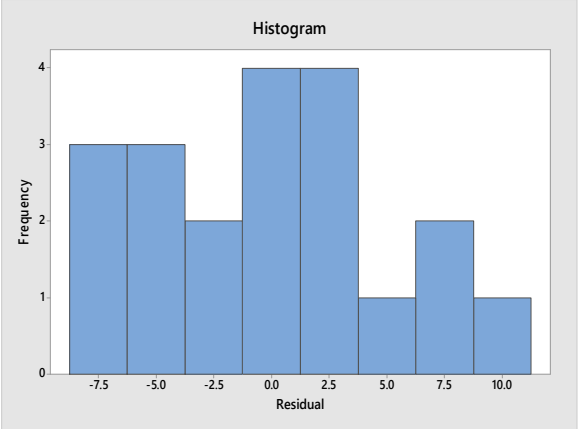


Figure 1. Residual plots of compositions

E. Normal Probability Plot

The normal, or probability, plot is made by maneuvering the stored numbers vs. an estimate to the means or medians of the matching organize statistics. If the data is reliable with a sample from a normal distribution, the point should lie close to a linear line. As an orientation, a straight line can be suitable for the points. The more the points vary from this line, the larger the sign of deviation from normality. In the figure above, the residuals are scattered around the straight line and follow the reasonably straight line, and the histogram shows that the plot of the residuals forms a normal distribution centred at zero. So the normality assumptions are satisfied[15].

F. Residual vs. Order of Data

In the above figure, the residuals are randomly scattered around the centre line, so no independent assumption is taken, and it shows that the residuals are independent of one another.

G. Residual plot vs. fitted data

In the above figure, residual versus fitted data is randomly distributed on both borders of the centre mark. So the data has constant variance.

The data satisfied all the assumptions. To a perform one-way ANOVA at a confidence interval of 95% on Minitab for further analysis.

H. Results from one way ANOVA Minitab

The null hypothesis states that the mean of all twenty compositions is alike. But the P-value, which is less than 0.05 shows that there is enough evidence that not all the means of the composition are equal at the 95% confidence interval. So the null hypothesis is rejected, and the team concluded that some compositions have different means for the ignition of match sticks due to the striking surface of the match box[16]. For selecting the best composition and for further analysis, a boxplot has been plotted.

I. Box Plot for Best Composition

The box plot shows that high numbers of matches are ignited at levels S4 and S7. All others have a low rate of igniting units. S4 and S7 are selected for further analysis.

The two compositions at levels S4 and S7 are further analyzed by the cost analysis. These two have almost the same mean, but to find the best one, team focused on its cost analysis[17].

J. Cost Analysis of Selected Compositions

Two compositions are selected for cost analysis. The total weight ratio of different ingredients for a given composition is equal to 100. The cost per kilogram is calculated with the help of laboratory management, and the price of the ingredients has also been calculated[18]. In this step, the composition with the lowest cost will be selected between S4 and S7.

TABLE VIII. COST ANALYSIS OF SELECTED COMPOSITIONS

		Compositions Number	
Composition ingredients	Cost per kg	S4	S7
Red phosphorus	20000	45	55
Varnish	2400	22	13
Powdered glass	10000	11	15
Kerosene oil	50	10	10
Hard dryer	5000	7	6
Others (biner etc)	2000	5	1

The cost of the selected composition is shown. As the composition of S4 has a minimum cost, it has been selected as the best composition among all.

K. Minimization of Spindles on the Box Filling Machine

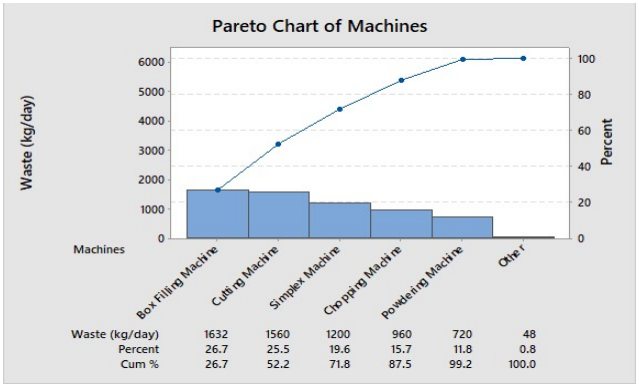


Figure 2. Pareto Chart for the Box Filling Machine

Considering the box filling machine, most of the spindles fall during movement on the conveyor for box filling. Falling spindles are crushed under the feet of workers after falling. A total of 25 machines are working, and the total waste on each machine is 4kg per shift[19].

Workers are Advised to stand on a steel rack spaced apart. As a result of which spindles don't get crushed[20]. Falling spindles are then placed on the track of the conveyor system to fill matchboxes.

As 4kg of waste is produced from each box filling machine. After the installation of racks, waste is reduced by almost 50%, specifically on these machines. The installation cost of steel racks was Rs1,00,000.

L. Minimization of Waste on the Cutting Machine

The daily consumption of wood in this industry is 4 to 5 trucks. One truck has a weight of 13000 kg, and the price of 1 kg of wood is Rs. 12.2. If bringing a wooden log according to the multiple of 44cm result in a reduction of waste, then the price of wood per kilogram will increased from 12.2 to .5 per kg.

Cost Analysis: Before

TABLE IX. DAILY WASTES OF THE MATCH INDUSTRY (KG)

Cutting machine	1200
Head cuts or roots	800
Wooden logs	3000
Black skin	5300
White skin	2600
Spindles waste	295
Total	13195
Price of wood	12.2
Total cost of wastes	160979

$$\text{Daily wood consumption price} = 1300\ (1\ \text{truck weight}) \times 5\ \text{trucks} \times \frac{12.2}{\text{kg}}\text{price} = 93{,}000$$

They sell black and white skin at a price of Rs. 3.60 per kg.

$$\begin{aligned}\text{Daily profit} &= 3200\ \text{cottons} + \text{white skin} + \text{Black skin} \\ &\quad - \text{wood consuption} - \text{transportation cost} \\ &\quad - \text{cost of wastes} \\ &\quad - \text{price of cotton and boxes} \\ &= 5378440 + 19080 + 9360 - 793000 \\ &\quad - 5000 - 160979 - 50000 \\ &= \text{Rs.}\,43{,}97{,}901/\text{day}\end{aligned}$$

After implementing a solution to bring a wooden log multiples of 44cm.

Now, the wood cost per kg is Rs. 12.5.

$$\begin{aligned}\text{Daily wood consumption price} &= 13000 \times 5 \times 12.5 \\ &= \text{Rs.}\,812500\end{aligned}$$

TABLE X. DAILY WASTES OF THE MATCH INDUSTRY (KG)

Wooden logs	3000
Black skin	5300
White skin	2600
Spindles waste	250
Total	11150
Price of wood	12.5
Total cost of wastes	139375

$$\begin{aligned}\text{Daily profit} &= 3200\ \text{cottons} + \text{white skin} + \text{Black skin} \\ &\quad - \text{wood consuption} - \text{cost of wastes} \\ &\quad - \text{price of cotton and boxes} \\ &= 5378440 + 19080 + 9360 - 812500 \\ &\quad - 139375 - 50000 = \text{Rs.}\,44{,}05{,}005/\text{day}\end{aligned}$$

Because of this solution, the daily profit of the industry has increased from Rs 43,97,901 to Rs 44,05,005 and from 14 to 15 crore annually.

VI. IMPROVW PHASE

A. *Falling Spindles during movement on the Conveyor for Box Filling*

Considering the box filling machine, most of the spindles fall during movement on the conveyor for box filling. Falling spindles are crushed under the feet of workers after falling. A total of 25 machines are working, and the total waste on each machine is 4kg per shift.

Workers were suggested to stand on a steel rack spaced apart. As a result of which spindles don't get crushed. Falling spindles are then placed on the track of the conveyor system to fill matchboxes[21].

As 4 kg of waste is produced from each box filling machine. After the installation of racks, waste is reduced by almost 50%, specifically on these machines. The installation cost of steel racks was Rs. l,00,000.

Figure 3. Installation of steel racks on Box Filling Machines

B. *Implementation of Steel Racks for Falling Spindles for Box Filling*

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As 4 kg of waste is produced from each box filling machine. After the installation of racks, waste is reduced by almost 50%, specifically on these machines[22]. The installation cost of steel racks was Rs. l,00,000.

Figure 4. Installation of steel racks on Box Filling Machines

C. *Implementing Solutions*

Planning for implemenations is mainly the substance of elementary project management. Mohsin Matchbox Industry needs to plan the budget for improving each proposed solution

by taking on the responsibility itself through personnel involvement.

In the Mohsin Matchbox Industry, there is no cost directly related to the implementation of the improvement[23].

In a nutshell, if the industry really manages to implement these proposed solutions, then it would be one of the leading industries with the lowest waste production as compared with others. The industry, however implemented the steel racks, which helped them save a lot of money as profit and also improve the quality of the product[24].

VII. CONTROL PHASE

After the analysis and improvement, it is necessary to control and maintain the changes that we have made in the process. In this phase of DMAIC (the Control phase), it is ensured that the improvements obtained during the improvement phase are continued and controlled. For this purpose, it is essential to systematize and document measures[25]. All personnel and management should be trained and communicate properly with the changes that have been made so that they become familiar with the new criteria and technology. In addition, a new plan should be created for continuing monitoring of the process and responding quickly to any difficulties that arise.

The observing strategy simplifies how the process of enactment will be constantly examined, who will be reported if a problematic situation arise, and what response is required. The waste on every machine should be reviewed on a daily basis, and a Pareto chart should be constantly updated so that the process owner can look out for problems and notice them[26]. The report should be printed and checked daily to ensure that all processes are according to the standard or not. If there is any problem found in the report and Pareto chart, the management should be able to contact the key operator for the production run and ask them the question they feel is necessary.

The management should also brainstorm the problems that have occurred and provide appropriate solutions for it. As a result, the system would be able to resolve problems immediately after they occurred.

Production line monitoring ensured the control phase through statistical analysis, which helped to trace the overlapping trend phase for a specific time period[27]. While the management can draw many conclusions through the analysis of daily reports with regards to current practices and potential changes to be made, It will help management to drive an optimal understanding of processes and their capabilities, which results in strong control over the production processes[.

Conclusion

Mohsin PVT Ltd. is one of the best-match production industries. They supply good-quality matches not only to Asian countries but also to African countries. They were facing some production-related problems, like rejection during the printing of sheets for box making and rejection of match sticks. The rejection rate of match sticks was 34%, and that of match boxes was 9.75%.

Results

The targeted industry, Mohsin Enterprise (PVT) Ltd., was selected because the team suspected a problem related to the quality of the process. The team further collected data from different departments in the industry. The rejection rate for each department was collected with the help of industrial employees. Further, the data was analyzed with the help of different tools like Minitab and Excel. Areas that needed more attention were box filling machines, cutting machine, and the printing of the chemicals on the striking surface of the match box. The team further investigated the cause of rejection in the printing department. The main cause of misprinting of chemical over the striking surface was improper mixtures of chemicals compositions. They were using improper ratios of chemicals. Twenty different tests were conducted to find out which composition had the lowest rejection rate. Each test was replicated three times, and ANOVA was used.

- From this project, following outcome was attained:
- The Mohsin Matchbox Industry has increased production through the six-sigma DMAIC methodology.
- The DMAIC methodology helped workers do their tasks with less effort by improving the processes.
- To bring the wood according to the length of the cutter in the cutting machine, which is a multiple of 44cm, reduced waste, which increased profit by one lac per day.
- The installation of steel racks helped reduce the industry rejection rate to almost 50%, specifically on box filling machines.
- The execution of the six-sigma DMAIC approach also improved the quality of the product.

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