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Can Six Sigma Enhance Quality in Small Scale Industries? : A Case Study

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Abstract: The objective of this research paper is to study a real time problem in a small scale Inder Enterprises & Engineers Company at Mohali. The company manufactures different types of mechanical lifts. The company faces a problem of Carriage Plate Rejection which is main component of lift. The main cause for this is dimension of slot, incorrect marking of plate, surface finish and burrs. Six Sigma methodology was used to eliminate the defect. Histogram, process capability Analysis, Pareto Diagram etc were used to study different defects in Carriage Plate and Fishbone diagram is used to briefly explain the reasons of defects. Three important factors were analyzed with the help of Two Sample T-test and an action plan was created for improvement and controlling the quality of carriage plate.

Keywords: Define, Measure, Analyze, Improve, Control (DMAIC), Quality, Defects per Million Opportunities (DPMO), Six Sigma.

I. Introduction

Six Sigma first conceived in early 1980s in Motorola considered as a quality management tool and applied all over the world. Many company gains benefit after applying the Six Sigma strategy. Well known examples of Six Sigma companies like Motorola, General Electric, Polaroid Sony, Honda, Lockheed Martin, American Express, Lear Corporation, Ford and Solectron. The development of quality is an important feature of industrial development of any economy. In a competition situation by growing quality cost of products reduce may help in improving the standard of living by making product available at more affordable prices. Six Sigma is a comprehensive system to achieve, maintain and take advantage of business success. The basic of Six Sigma is a detailed knowledge of customer requirements, geometric analysis and continuing efforts focused on optimizing business process. Six Sigma has been implementing with success in many large corporations and there are very few documented evidences of its implementation in smaller organizations. Quality and cost are the two key elements for the success of developed industry numerous definitions and methodologies have been created to assist in managing the quality-affecting aspects of production operations. Several special concept and technique have evolved to improve product or service quality.

II. Case Study

This project was carried out at Inder Enterprises and Engineers Mohali, which manufactures mechanical lifts like commercial, passenger, hospital, home, car, lifts etc and their parts like Carriage Plate which is main Part of lift Carriage Plate should have proper size marking, punching, surface finishing and the for the most part essential defect free. It was observed that the Carriage Plate has high rate of rejection. The sigma level is below three. While the original inspection show very poor results and the staff and management was willing to reduce the rejection rate and was cooperative in implementing the change, so a manufacturing industry was chosen for exhaustive study on implementing Six Sigma.

A. Define Phase

In define phase firstly the problem is defined and the customer needs were target out rising high level process map. Defects in the Carriage Plate of door operator of the lift. It was found that most of time the plate does not perform its operation which causes the working of door process. Due to the Carriage Plate noise came up at the time of opening and closing of door and due to the variations in the dimension of slot the door of lift is not open or closes smoothly.

B. Measure Phase

In measure phase the data is collect on the difficulty in Carriage Plate and its aim to check the measurement system is statistical or not. In measure phase, a measurement system analysis (MSA) was conducted which included the Gauge R&R (Gauge repeatability and reproducibility) studies. The purpose of Gauge R&R study is

to ensure that the measurement system is statistically, Gauge R & R studies determine how much of the observed process is stable.

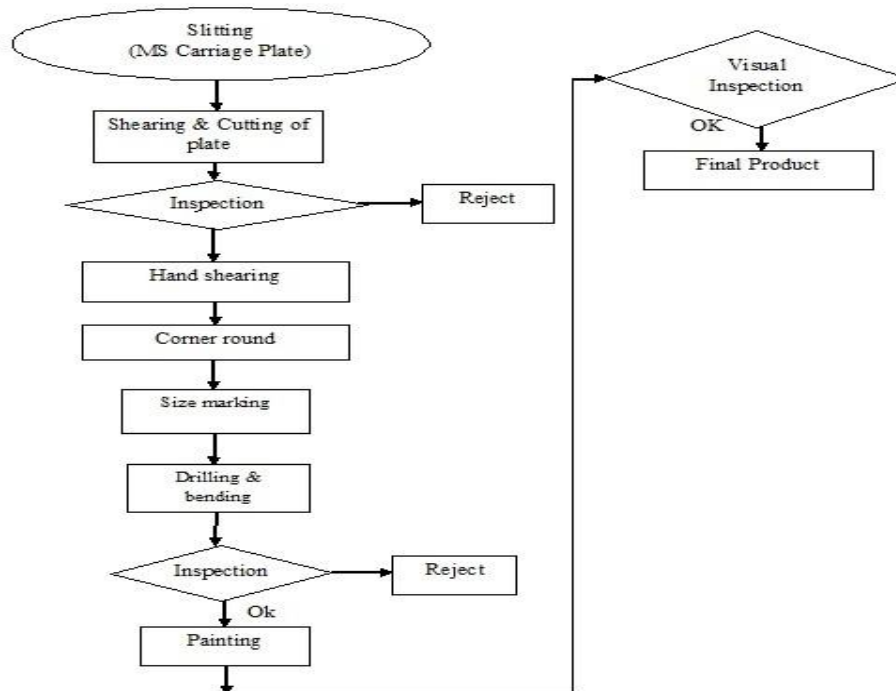


Figure.1 Process Map for Carriage Plate

Result of Gauge R & R as shown in table 1 which shows that the repeatability and reproducibility came out to be 19.92 percent and 0.00 percent which put the percentage study variation at 19.92 percent of Carriage Plate width slot which is less than 30 percent, indicating that verniercaliper was correct.

Table 1 Gauge R & R Study Results for Carriage Plate width slot

Source	Std Dev	Study Var (6*SD)	%Study Var (%SV)
Total gauge	0.027699	0.166195	19.92
Repeatability	0.027699	0.166195	19.92
Reproducibility	0.000000	0.000000	0.00
Part to Part	0.136254	0.817524	98.00
Total Variation	0.139041	0.834245	100.00

Result of Gauge R & R as shown in table.2 that the repeatability and reproducibility came out to be 22.42 percent and 0.00 percent which put the percentage study variation at 22.42 percent of Carriage Plate length slot which is less than 30 percent, indicating that verniercaliper was correct.

Table.2 Gauge R & R Study Results for Carriage Plate Length slot

Source	Std Dev	Study Var (6*SD)	%Study Var (%SV)
Total Gauge	0.031623	0.189737	22.42
Repeatability	0.031623	0.189737	22.42
Reproducibility	0.000000	0.000000	0.00
Part-to-Part	0.137437	0.824621	97.45
Total Variation	0.141028	0.846168	100.00

C. Analyze Phase

In this phase the system recognize ways to take away the gap between the current performance of the system and the desired goal. In which there are following tools were used for examine the data.

i) Histogram

Histogram is a graphical variation of data. It represents individual measured values according to frequency. The histogram for width of slot (figure 2) clearly shows that data was not centric and mean is beyond target (8.4) value, which shows the problem of centering. The histogram for length of slot (figure 3) clearly shows that data was not centric and mean was beyond target (33.4) which shows the problem of centric.

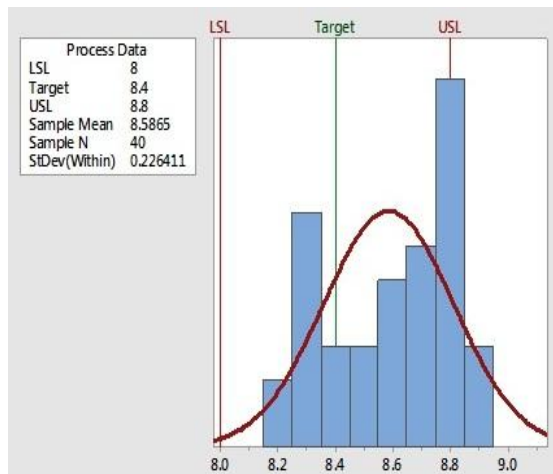


Figure 2 Histogram for Slot Width

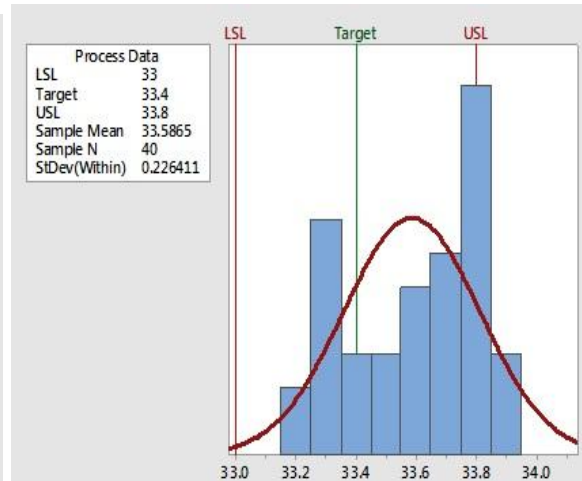


Figure 3 Histogram for Slot length

ii) Process Capability Analysis

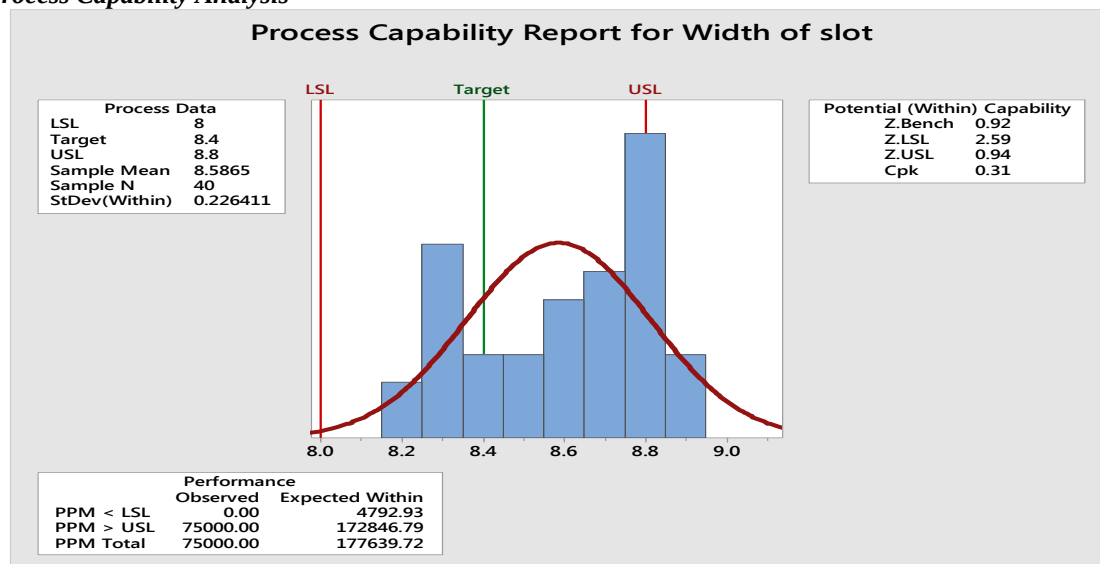


Figure 4 Process Capability Analysis of Width of Slot before Improvement

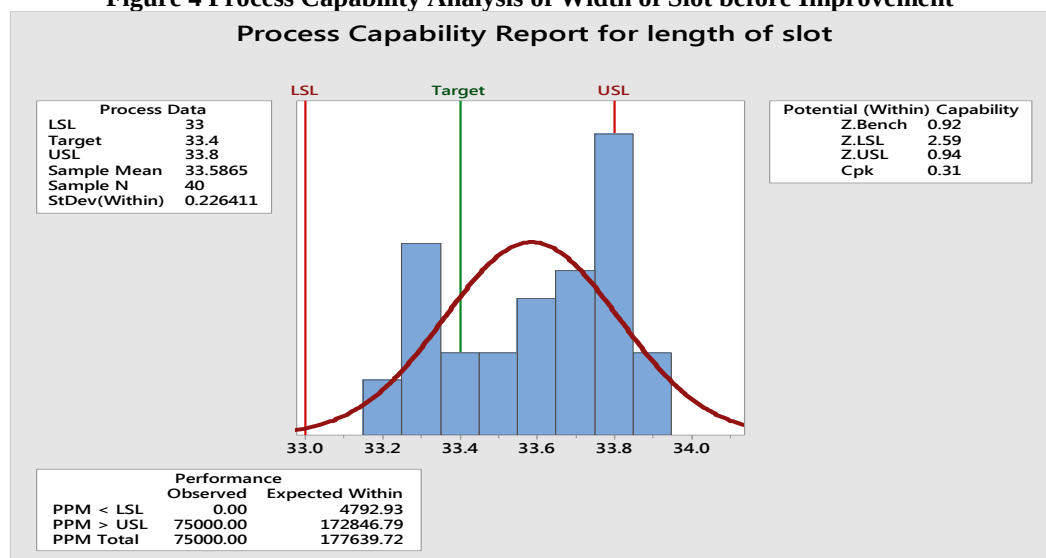


Figure 5 Process Capability Analysis of Length of Slot before Improvement

Minitab was used to draw process capability analysis curve for width of slot of Carriage Plate as

shown in figure 4 and figure 5, it was found that the Z- Bench sigma value of process was 0.92 and existing DPMO level of the process came out to be 177639.72 (for width) which is remarkably very high and for length the Z- Bench sigma value of process was 0.92 and existing DPMO level of the process came out 177639.72 (for length) that is remarkably high and this shows that there are lot of opportunities for improvement in the process.

iii) Cause and Effect Diagram

Cause and effect diagram also known as Ishikawa and fish-bone diagram .its complete diagrams look like fish skeleton. It shows relationship between variables and causes. It is don't basis on statistical, but excellent for solving the problems. Cause and Effect diagram was drawn to find out the causes of the variation of Carriage Plate rejection.

From all the SSV's the following suspect creating problem is considered for the further study.

- 1) Improper clearance of machine dies.
- 2) Improper lubrication.
- 3) Size marking is not proper.

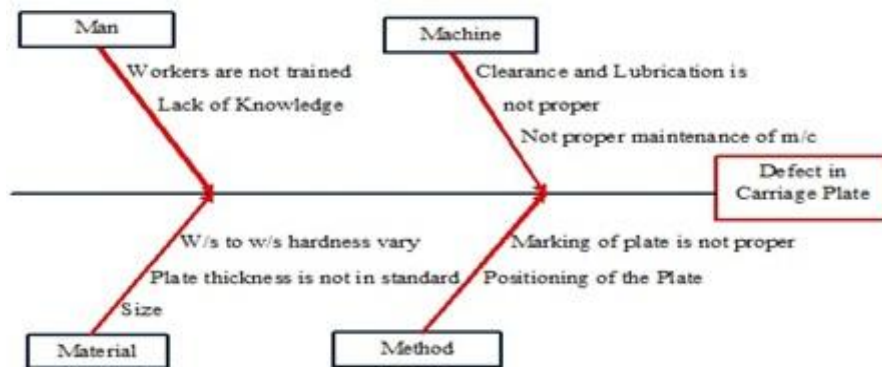


Figure 6 Cause and Effect Diagram

iv) Pareto Chart

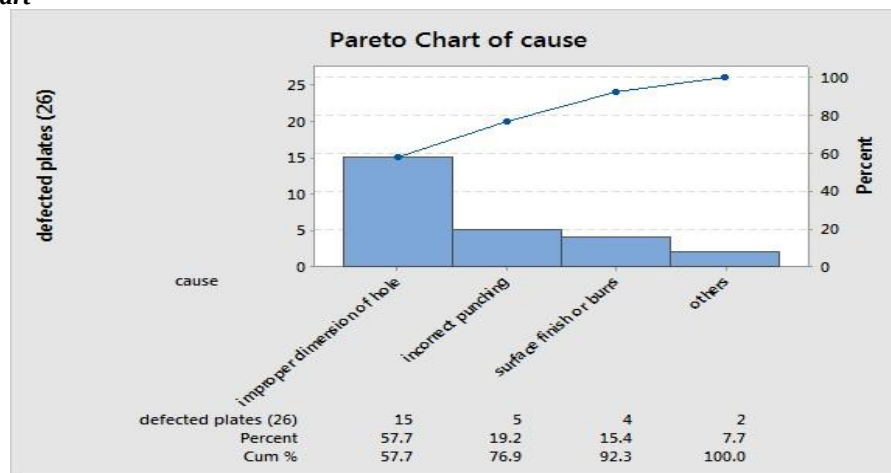


Figure 7 Pareto Chart

D. Improve Phase

In improve phase Two Sample T-Test and why and why analysis was done to find out the optimum conditions for the vital few factors found out after the Cause and effect diagram.

1). Two Sample T-Test

Case 1 Skilled and Unskilled operator

Using Minitab, The Two Sample T-Test showed that as the p-value for width slot of Carriage Plate is greater than 0.05, thus operator skill could not be factor for width and length slot of carriage plate rejection.

Case 2 Clearance (0.08mm and 0.15)

Since the p-value for clearance of width and length came out to be less than 0.05, that's why clearance may be a factor for plate rejection.

Case 3 New or Old Die

Using Minitab, the Two Sample T-Test showed that as the p-value of die (new and old) is more than 0.05; so the die is not part of carriage plate rejection.

2). Why and Why Analysis

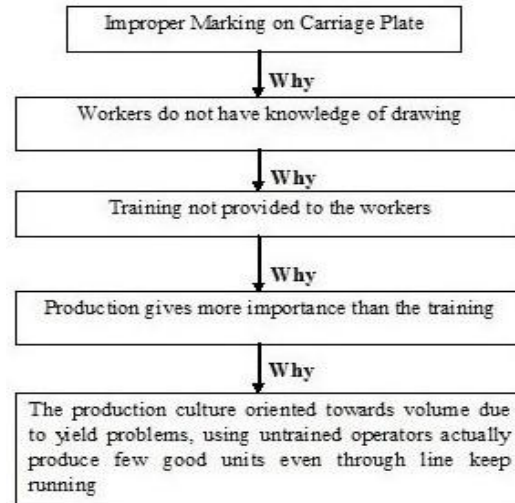


Figure 8 Why and Why Analysis

3). Action Plan (Improve and Control Phase)

Table 3 Action Plan (Improve and Control Phase)

Sr. No.	Recommendation Proposed	Status
1	Proper preparation and alertness about the drawing and marking to be provided to workers	Instruction being followed
2	Time to Time lubrication of die to be done at time of punching	Implemented Instruction Pasted
3	Setting of Clearance to be check before punching the plates	To be Implemented

E. Control Phase

The considered control solutions for improve the earlier solutions are listed in sequence as follow.

➤ Preparation and Alertness Program for Worker

- Instructions of preparation and alertness program for worker have been prepared to give complete knowledge of drawing.

➤ Use of lubrication in Die at time of punching

- The instructions of proper lubrication use at time of punching operation have given to the workers.

➤ Setting of Clearance for different size of Carriage Plate

- There is program constructed for worker to give them knowledge and an instruction list to be passed which contains all the clearance value for different thickness Carriage Plates in Company.

III. Results and Conclusion

With using the Six Sigma tool in Inder Enterprises and Engineers small scale Company. We brought up the sigma level from 0.92 (for width & length) to 3.05 (for width) 3.08 (for length) which is equal to the Rs 1.74 Lakhs per year and it is huge amount for a small organization.

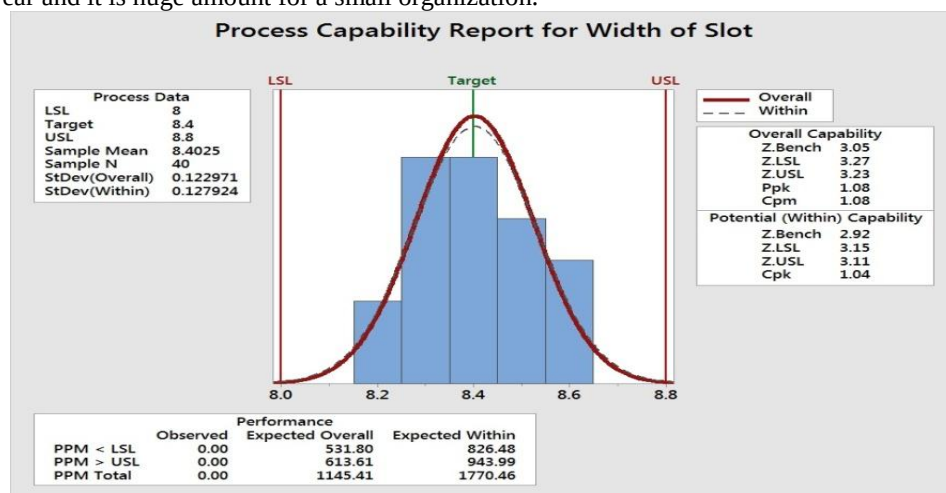


Figure 9 Process Capability Analysis of Width of Slot after Improvement

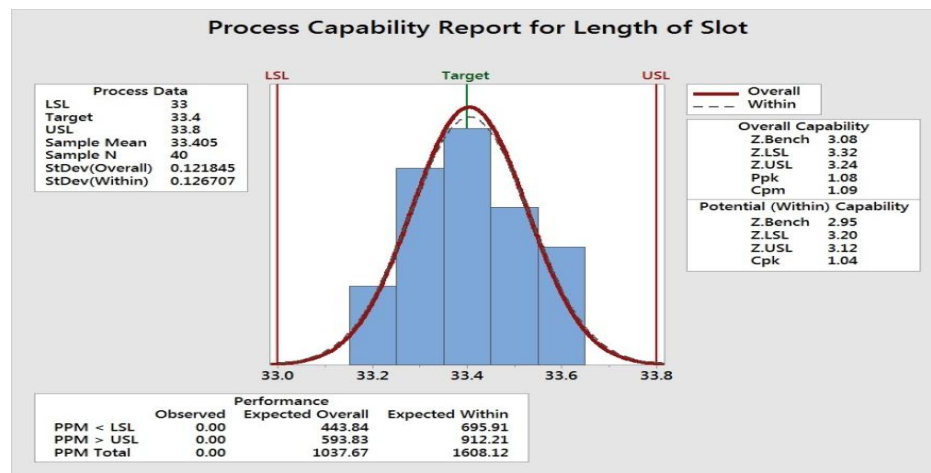


Figure 10 Process Capability Analysis of Length of Slot after Improvement

IV. Scope for Future Work

Six Sigma has large scope in Indian Small Scale Industries, but due to lack of knowledge and awareness on latest quality tool and statistical techniques among the management its implementation is very limited. In this context, the following aspects need attention for future research. A) Six Sigma can also be implemented over other SME industries such as foundries, power looms, rolling mills etc. to improve the productivity level. B) Six Sigma implications can be studied and explored over different service organizations like safety care, transportation, traffic management etc. C) Six Sigma implications can be calculated and explored even over organizations like hospitals, schools, colleges, universities etc. D) Six Sigma other Applications at other areas like in banking, receivable, production of the new products in minimum time, reduce purchaser complaints etc.

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