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Study and Analysis of Process Rejection in Output Gear

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***Abstract*: The sole purpose of this research is to implement six sigma DMAIC phase to minimize the rejection rate in manufacturing industry. Currently, the global market is moving towards on focusing to achieve zero defects. Six sigma leaves a significant mark on financial results which are achieved through virtual elimination of products and process defects. The defects are identified by using certain tools such as process flow, pareto chart, fish bone diagram. These tools are adopted to analyze the depth of the issue and to identify the key factors which is required for controlling and improving the overall expectations for the This research foresees to analyze a case study by implementing six sigma tool for minimization of rejection rate. After obtaining the result it was found that, rejection rate of a selected manufacturing industry is brought to 1.2% from 5.3% through the implementation of DMAIC.**

***Keywords*: Measure Analysis, Improve Control.**

1. Introduction

An output gear is a component in a transmission system. Its function is to exert output energy to move the vehicle. Here, while manufacturing output gear the usual problem that occurs are surface finish, gear face height issues. To avoid these manufacturing defects we plan to use six sigma approach to minimize the occurrence of manufacturing defect. As the safety measures are higher for the mentioned product, it includes various operations in order to satisfy all the safety measures. So it is compulsory to fix each and every problem that arises against safety. Humongous wastage occurs in an output gear manufacturing company, due to various defects caused in different operations. In this project we have been used six sigma tool, to bring down the wastage percentage and to improve the quality of the product and also for the profit of the manufacturing company.

Problem Identification:

The problem occurring during manufacturing of gear is that, the face height of gears has a specific dimension according to which gears are supposed to be manufactured. But after manufacturing, the face height value does not match the actual dimensional value. Which leads to loss of time and cost in manufacturing industry.

2. Literature Review

S. Nallusamy et al, (2018), "Minimization of Rejection rate using Lean Sigma Tool in medium scale manufacturing industry". They have found that rejection rate can be minimized using sigma tool, which shows better result by identifying the area where it occurs. The defect is identified by using pareto chart, fish bone diagram and they also help analyze depth of issue and improving the overall expectation for zero rejection rate.

Priyaansh Prasad and D. R. Prajapati et al, (2014), "Reduction of rejection of an automobile parts using six sigma approach". They have found that using six sigma methodology is used to reduce rejection and rework of honing process in an automobile part manufacturing company. Also their step by step process evaluation seems to be effective since six sigma considerably reduces industries cost and time.

Raheem Yousef, Shahid Ikramullah Butt, Riaz Ahmad et al, (2013), "Six Sigma implementation to reduce rejection rate of pump casing at local manufacturing company". The authors introduced six sigma as an optimal method to reduce the rejection rate. Using this method the authors brought the reduction rate from 27.25% to 2.158%, which is a very good result.

3. Methodology

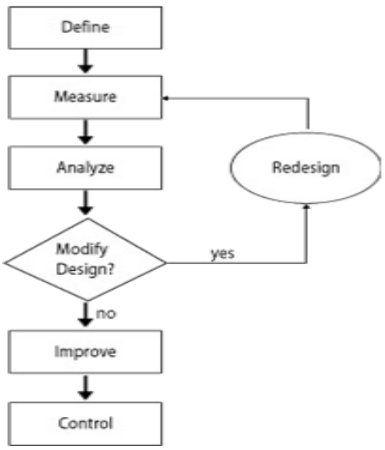

Fig. 1. Flowchart of methodology

This flow chart clearly shows the exact approach that is used to solve the process rejection that occurs in manufacturing gears. This is also one of six sigma tools which is mainly used to reduce the rejection rate by analyzing the data in a stage by stage approach which helps us to identify where the problem occurs. After identifying the problem improvisation is done to minimize the rate of rejection.

A. Define Phase

In the define phase, its problem statement and goals, were redefines by Six Sigma team which are critical to quality. This also ensures the business goal, priorities and expectations. This phase also helps us to clarify the issue of the project, in this first step, it is necessary to focus on the process that generates the product and the map in order to be familiar. As the for face height before heat treatment should be within 38.7 +0.025 and -0.025, the work pieces which does not satisfies the given dimensions are made to be rejected. The specific allowances for face height may be within +0.025 and –0.025.

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Fig. 2. Height measuring instrument

B. Measure Phase

A step of collecting data on measurable parameters of the process is called Measure phase. It determines what is able to provide the process in question namely its sigma is the objective. During this stage, it is important to focus on critical parameters for the quality, that is, those whose influence on the result is the largest. Measuring instruments like air gauge, coordinate measuring machine (CMM), etc. which are normally used in many industries. Because of the reason that the output gear has the critical dimension, air gauge is used for measurement. Some sample work pieces undergoes air gauge measuring for regular shifts. In order to identify the severity of rejection rate, bar graph was made based on rejections produced each day. The bar graph chart reveals the, actual rejection rate of the company for the time period of one month of Feb-Mar 2020. The average rejection rate in measure phase is 5.34%. Hence the rejection rate is decreased to meet the increase in production rate, higher quality.

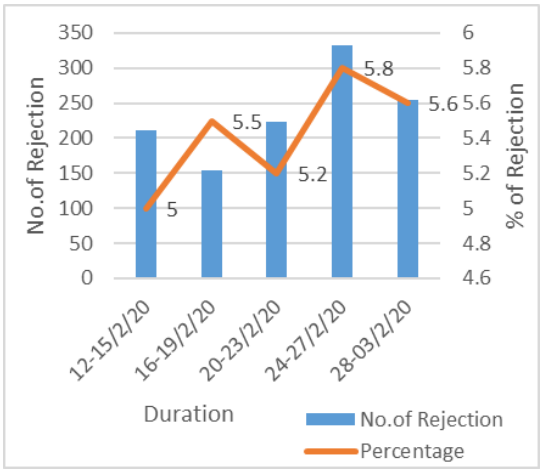

Fig. 3. Pareto chart on actual rejection rate

This chart shows the rejection that were attained before implementing the Six Sigma. This pareto chart shows the increasing percentage of daily rejections on output gear.

C. Analyse Phase

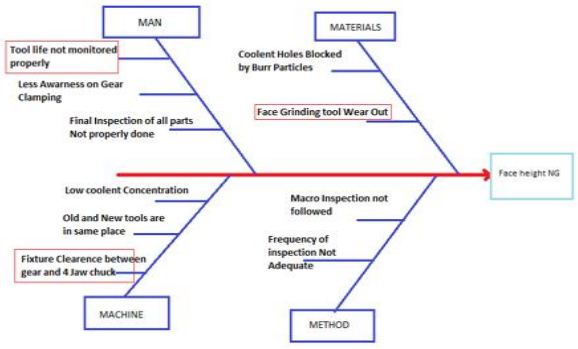

Fig. 4. Cause and Effect diagram

The identification of the root cause, makes an impact on the rejection rate of the work piece is called Analyse phase. some subcritical factors were given example by cause and effect diagram. Consequently, the brainstorming sessions were conducted to identify the major critical factors that make an impact on the rejection rate. The major causes are bore line

mark and bore under size and the minor causes are highlighted by the red boxes is make clear. Hence, in the brainstorming session the solutions for rectifying the defects are discussed seriously. It was identified that, the reasons for face height error are tool wear out, tool life not monitored for re-tipping and also improper manual clamping. The cause for face height error is due to the fixture clearance between the block and part. These main reasons are convectively analysed to make improvements to reduce the rejection rate.

D. Improvement Phase

The phase that concentrates on embarking the current system configuration, which enlightens the minimization of rejection level is called Improvement phase. This stage was functioned through a strong brain storming session with all the team members and experts of the department. The whole team discussed the current status of the system. After clear investigation, the consensus reveals that, the permanent corrective measures to avoid bore line mark is to replace the tool before the last 2% of the overall tool life, Creating awareness among the workers for proper and regular monitoring of tools.

To avoid Face Height NG, butting the gear in between jaws, face height of output gear was checked both before and after Heat Treatment, proper instructions were given to the operators and patrol inspectors about Face height dimension. By Implementing these ideas the major two defects should be eradicated, That affects the overall production rate of the industry. A Pareto chart was prepared after implementing the ideas for the improvements to avoid the major effects. The results of Pareto chart reveal the minimized rejection rate of the company for time period of Feb-Mar 2020. As per the results from the analyze phase it was found that the average rejection rate in 1.2% and the graph clearly depicts that the rejection rate decreases gradually. Hence the rejection rate meets the increase in production, higher quality and customer expectation.

1) *Raw Material Value*
(Actual value: 33.865-33.880)
- 33.866~33.868
- 33.871~33.877
- 33.872~33.877
- 33.869~33.875
- 33.863~33.866

2) *Before Heat Treatment Machining*
(Actual value: 33.715-33.730)
- 33.725~33728
- 33.720~33.727
- 33.718~33.729
- 33.717~33.720
- 33.715~33.724

3) *After Heat Treatment (33.8+-0.025)*
- 33.839~33.848
- 33.839~33.843
- 33.839~33.846
- 33.834~33.846
- 33.829~33.874

4) *After Heat Treatment Machining*
(Actual value: 33.775-33.825)
- 33.807~33.824
- 33.771~33.788 •
- 33.809~33.833 •
- 33.799~33.807
- 33.770~33.793 •

E. Control Phase

In this phase, comparison between times of preventive works before and after using six sigma tool and also the gains have been achieved by the team personnel through refined process that yield maximum remunerations. In improve phase, the manufacturing industry implemented the optimal solution to achieve continuous improvement on minimization of rejection rate. At this phase various supervisory activities are designed for all the term members and it took lots of suggestions from the top management also. Consequently, the overall of rejection rate of the manufacturing company is enhanced by analyzing and identifying the critical defects of the work piece. Further improvement in overall minimization of rejection rate can also be done by analyzing and identifying various defects in other operations on the work piece and other models too.

Now, the rejection rate of the industry is brought to about 1.2% from 5.3%. If the Face Height of the Output gear is maintained between the dimensions and the analyzed defects are rectified continuously, the rejection rate of the manufacturing industry could be improved more and may be taken to zero as well.

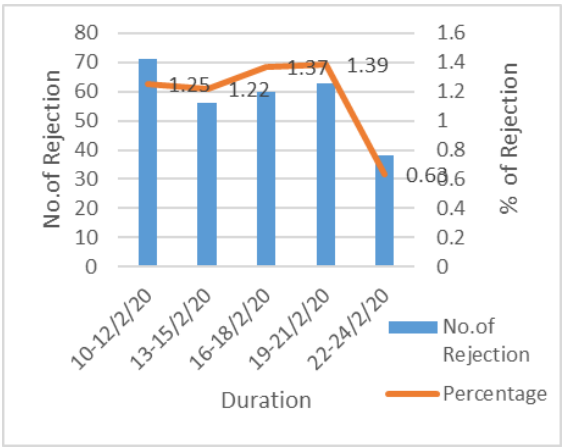

Fig. 5. Pareto chart on minimized rejection rate

Here in this pareto chart it shows that the rejections have been reduced after implementing the Six Sigma approach. It shows decreased rejections from 5% to 1% and gradually decreasing.

4. Conclusion

In the past few years successfully implementing and growing organizational interest towards six sigma method have been exploding. The successful and influential six sigma projects

include management involvement, project management, control skills, organizational commitment and short coming of six sigma provides wonderful opportunities to practitioners for successful Moreover, making data-driven in a clear approach as well as, the hierarchy of six sigma process into organizations still has room for improvement. It integrates the lesson learned from successful six sigma projects and considers further improvements to the six sigma approach.

Based on the analysis and results the following conclusions were arrived.

1) Our conceptual frame work purpose new insights to the managers in an organization that typically interacts with education and quality.
2) To achieve this, Six Sigma approach with the proactive methodology of DMAIC is applied.
3) The overall rejection rate is reduced from 5.3% to 1.2% after implementation of Six sigma.
4) The delivery schedule of the product is met at right time.
5) Customer satisfaction is obtained at the positive side.

Further improvement in overall minimization of rejection rate can also be done by analyzing and identifying various defects in other operations.

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