MINIMIZATION OF REJECTION RATE USING LEAN SIX SIGMA TOOL IN MEDIUM SCALE MANUFACTURING INDUSTRY

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ABSTRACT

The objective of this research is the pilot implementation of six sigma DMAIC phases to improve the rejection rate of manufacturing industry. The current global market is focusing on zero defects that are 3.34 defectives per million parts produced. Six Sigma places the emphasis on financial results that can be achieved through the virtual elimination of products and process defects. Profits and industry stakeholder value is maximized. In this research it is proposed to analyze a case study by implementing six sigma tool for minimization of rejection rate. The defect is identified by process flow, pareto chart, fish bone diagram and all were also adopted to analyze the depth of the issue and to identify the critical factors which is required for controlling and improving the overall expectations for the zero rejection rate. From the results it was found that, rejection rate of the selected manufacturing industry is brought to 1.2% from 5.3% through the implementation of DMAIC.

Keywords: Lean, Six Sigma, DMAIC, Rejection Rate, Wheel Cylinder


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1. INTRODUCTION

A wheel cylinder is a component in a drum brake system. It is located in each wheel and is usually positioned at the top of the wheel, above the shoes. Its function is to exert force onto the shoes so as to bring them into contact with the drum and stop the vehicle with friction. The wheel cylinders are usually connected to the shoes with small bird-beak shaped rods. On older vehicles these may begin to leak and hinder the performance of the brakes, but are
normally inexpensive and relatively easy to replace. The wheel cylinder consists of a cylinder that has two pistons, one on each side. Each piston has a rubber seal and a shaft that connects the piston with a brake shoe. When brake pressure is applied, the pistons are forced out pushing the shoes into contact with the drum. Wheel cylinders must be rebuilt or replaced if they show signs of leaking. Wheel cylinders used to be made of cast iron. However, they were more prone to rusting and aluminium is now the preferred material. 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 a wheel cylinder 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.

2. LITERATURE REVIEW

As per Toyota’s production system, lean manufacturing can be defined as ‘A systematic approach to identifying and eliminating wastes through continuous improvement by making the product at the pull of the customer in pursuit of perfection’. Waste can be eliminated and lean development can be achieved by various tools such as 5S, Kanban, Kaizen, Value stream mapping and Work standardization [1-5]. VSM is a process for analyzing the current scenario and to design a future scenario for framing the sequence of activities that takes a product from its beginning through to the consumer. VSM is used as a main tool to identify the opportunities for various lean techniques. Different research articles have discussed the various applications of VSM technique like aircraft, supply chain, logistics, healthcare, service related industries and information flow analysis in different manufacturing industries [6-10]. A supply chain model was to achieve success in agile supply chain where the system should adapt to changes immediately and the stakeholder should possess knowledge about the various stages of the supply chain and share the information at the right time to sustain the agility in the supply chain was proposed [11-15]. Multi objective mixed-integer linear program with total cost, total flow time, and total lost sales as key objectives was developed for addressing production, distribution, and capacity planning of global supply chains by considering cost, responsiveness, and customer service levels simultaneously [16-20]. A customized Artificial Neural Network (ANN) model that allows changes for the decision-making process was proposed. The model employed with fuzzy analytics hierarchy process (FAHP) for determining the relative weights of the attributes used posteriorly in the ANN model with back propagation learning [21-24]. The inventory management practices of various companies and institutions were studied and compared with necessary suggestions for improvement using the ABC analysis inventory management method. The ABC analysis was found to be useful to most of the companies already in usage of this tool either manually or with an enterprise resource planning system [25-29]. Projects were undertaken to identify areas in the process where extra expenses did exist and introduced appropriate measurement system, which reduced expenses on production times. The variables influencing the chosen characteristics and then optimized the process in a robust and repeatable way were represented and focused on what six sigma is today and its roots in both Japan and in the west and what Six-Sigma offers the world today [30-34]. Six sigma is a lean tool to improve the business policy which makes an attempt to develop the maximum efficiency and effectiveness of all the production processes to fulfill the customer requirements [35-38]. By implementing Six sigma Define, Measure, Analyze, Improve, Control (DMAIC) a revolutionary approach with its statistical tools and techniques in different processes, quality along with the monetary savings can be achieved. A distinct methodology for integrating lean manufacturing and Six Sigma philosophies in manufacturing facilities were highlighted [39-42]. Based on the above
literature a study was made on implementation of six sigma using DMAIC methodology in automotive spare parts manufacturing industry cited at Chennai.

3. PROBLEM DEFINITION AND METHODOLOGY

An industrial process includes a number of repetitive tasks, the most grotesque example being the production of a room in high volume. A room is compliant if it meets a number of criteria. However, all the exhibits can’t be strictly identical. One of major concern of quality management is how to master the conditions of production so that there is as little waste, the least possible customer dissatisfaction. Hence, the manufacturing industry does more work on wheel cylinder model of RBI, when compared to other models like GS, HA, AH, S101, LCI, MY15, etc. RBI model wheel cylinders are used in majority of the cars. So, the selected manufacturing company faces more rejections in RBI model comparatively. So, we are concentrating on the rejection percentage of RBI model to bring down the overall rejection rate of the industry. The methodology adopted is expected to cover over all possible causes of the problems (or) issues. If the methodology used for solving the problem is not comprehensive enough, the solutions obtained in completion may not be correct and the problem is likely to resurface faster or later also. To increase the production rate through minimizing the rejection rate of components at automotive spare parts manufacturing industry, the methodology adopted using Six Sigma DMAIC a five stage improvement cycle is given as a flow chart in Figure 1.

Figure 1 Methodology Flow Chart
4. DATA COLLECTION AND ANALYSIS

4.1. DMAIC Chart
To implement Six-Sigma, it must follow DMAIC approach step-by-step as shown in Figure 2. This approach is briefly described for the concerned organization. Lack of proper analysis may lead to the process to a wrong way, which will deviate from the main function of improvement. Every successful work goes on some specific sequence. This work also completes some specific step. After completing each successful step, it is necessary to move next step. Methodologically the total process of the work is divided into two basic stages, measurements and improvements. The DMAIC is a basic component of Six-Sigma methodology- a better way to improve work process by eliminating the defects rate in the final product. Six sigma is the statistical breakthrough tool which improves the existing performance level of business strategy and controls the variations in the processing stage to less than the actual rejection rate.

![DMAIC Approach using Six Sigma](image)

**Figure 2** DMAIC Approach using Six Sigma

4.2. D for Define Phase
In the define phase, a Six sigma team refines its problem statement and goals, identifies the factors 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 major safety dimension (i.e.) Bore diameter of the RBI model wheel cylinder lies between 17.767 ~ 17.793 mm, the work pieces which do not satisfies the given dimensions are made to be rejected. The specific allowances for bore diameter may be within +0.013 microns. We can easily able to notice that, the bore machining operation is highlighted in the given process flow chart shown in Figure 3.
Hence, it is defined that majority of the rejection takes place in the boring operation. Accordingly, bore line mark and Bore undersize are the major defects which are the reason for increase in rejection. As the safety measures are concerned for the customer’s satisfaction these defects must be rectified for good quality assurance. It is necessary to analyse these defects in order to control the overall rejection rate of the manufacturing company.

4.3. M for Measure Phase

Measure phase is a step of collecting data on measurable parameters of the process. The objective is to determine what is able to provide the process in question namely its sigma. 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. There are many measuring instruments like air gauge, coordinate measuring machine (CMM), etc. which are normally used in many industries. Because of the reason that the wheel cylinder has the critical dimension, air gauge is used for measurement. Certain sample work pieces undergoes air gauge measuring for regular shifts. In order to identify the severity of rejection rate, Pareto chart was constructed as shown in Figure 4. The Pareto chart reveals the, actual rejection rate of the company for the time period of one month of December 2017. As per the measure phase the average rejection rate is 5.34%. Hence, the rejection rate must be decreased to meet the increase in production rate, higher quality and customer expectation.

**Figure 3** Process Flow Chart
4.4. A for Analyze Phase

In analyse phase, the identification of the root cause, makes an impact on the rejection rate of the work piece. In this regard, various subcritical factors were illustrated by cause and effect diagram as shown in Figure 5. Consequently, the brainstorming sessions were conducted to identify the major critical factors that make an impact on the rejection rate. From Figure 5, it is clear that the major causes are bore line mark and bore under size and the minor causes are highlighted by the red boxes. Hence, in the brainstorming session the solutions for rectifying the defects are discussed seriously. It was identified that, the reasons for bore line mark are reamer tip wear out, tool life not monitored for re-tipping. The cause for bore ovality or bore under size 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.
4.5. I for Improve Phase

The improve phase concentrates on embarking the current system configuration, which enlightens the minimization of rejection level. This stage was functioned through a strong brainstorming session with all the team members and experts of the department. The whole team discussed the current status of the system. After fierce 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, proper and regular monitoring of tool, creating awareness among the workers. To avoid bore under size, butting the unwanted blocks, bore diameter was checked for both sides of the work piece, proper instructions were given to the operators and patrol inspectors about bore under size. Implementing these ideas these two major defects should be eradicated, which 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 which are shown in Figure 6. The results of Pareto chart reveal the minimized rejection rate of the company for time period of January 2018. 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.

4.6. C for Control Phase

In control 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 wheel cylinder 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 bore diameter of the wheel cylinder 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.

![Figure 6 Pareto Chart on Minimized Rejection Rate](http://www.iaeme.com/IJMET/index.asp)
5. CONCLUSION
Successful implementation and growing organizational interest in six sigma method have been exploding in last few years factors influencing successful six sigma projects include management involvement and organizational commitment, project management and control skills, cultural change, and continuous training understanding the key features, obstacles, and shortcomings of six sigma provides opportunities to practitioners for better implement six sigma projects. However, integrating the data-driven, structured 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.

- Our conceptual framework purpose new insights to the managers in an organization that typically interacts with education and quality.
- To achieve this, Six Sigma approach with the proactive methodology of DMAIC is applied.
- The overall rejection rate is reduced from 5.3% to 1.2% after implementation of Six sigma.
- The delivery schedule of the product is met at right time.
- A positive step towards zero defects with customer satisfaction.
- Regular monitoring and controlling is adopted.

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.

REFERENCE


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Minimization of Rejection Rate Using Lean Six Sigma Tool in Medium Scale Manufacturing Industry


