To Improve the Machine Efficiency and Reduce Non-Confirmative Rate of Bearing Ring With Help of Six-Sigma Methodology

Divyeshkumar U. Patel[1] Dixit M. Patel[2] Raviprakash C. Patel[3] Jitendra J. Patel[4]
[1,2,3,4]Department of Mechanical Engineering
[1,2,3,4]Ahmedabad Institute of Technology, Ahmedabad

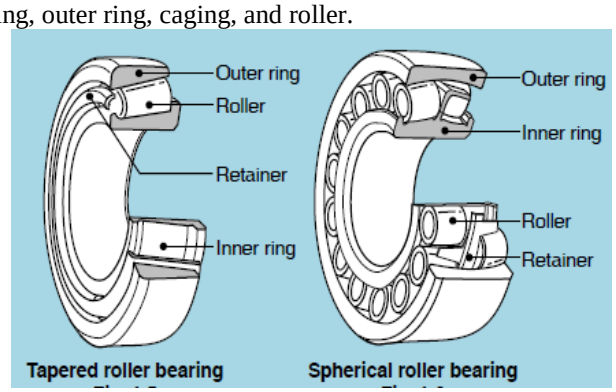
Abstract— In recent year an increasing member of companies have used different types of quality programs in order to increase internal and external customer satisfaction as well as to reduce quality cost Among all of these programs six sigma is perhaps the most widely accepted initiative by all a broad range of organization. The six sigma approach has been increasingly adopted worldwide in the manufacturing sector in order to enhance productivity and quality performance and to make the process robust to quality variation This project discuss the process variation. This project discuss the process variation reducing the process variation and bearing reducing the rework by Appling DMAIC approach Project deals with application of six sigma DMAIC methodology in an industry which provides a frame work to identify quantity and eliminate sources of variation in an operation process in question to optimize the operation verifies improve and sustain performance process yield with well exerted control plans six sigma improve the process performance of the critical operational process leading better utilization of recourses decreases variation and maintain consistent quality of the process output. This study focus on Reducing Non-confirmative Rate of Bearings Rings Using DMAIC approach of six sigma methodology.

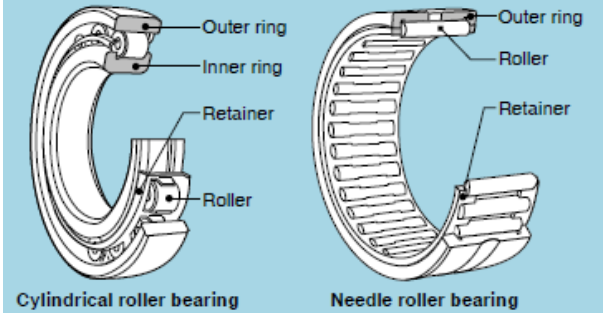
Key words: Reduce Non-Confirmative, Six-Sigma Methodology

I. Manufacturing Process of Bearing Rings

A. *Bearing process*

Bearings are manufactured by different parts. like internal ring, outer ring, caging, and roller.





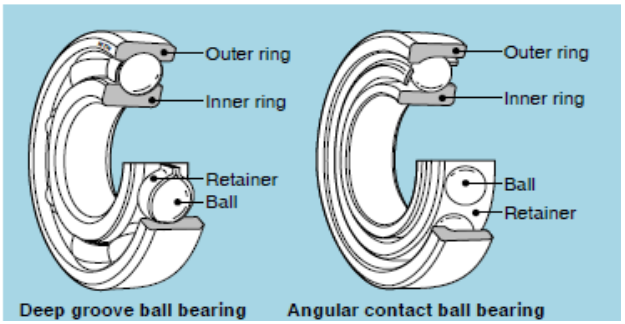


Fig. 1: Types of Bearing and its parts [1]

B. *Ring Manufacturing Process*

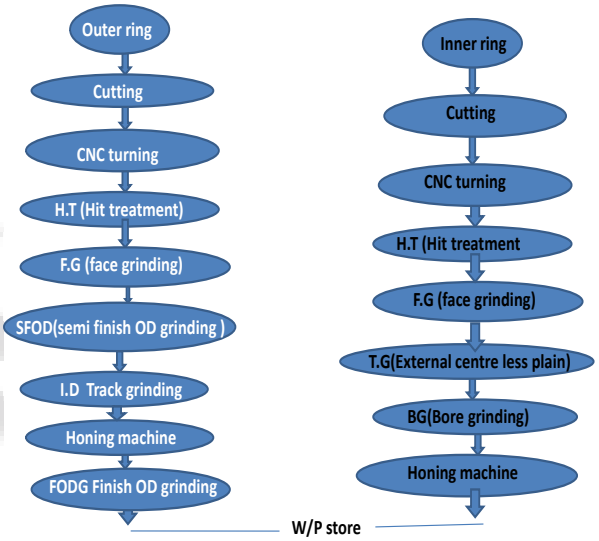


Fig. 2: Ring Manufacturing Process [2]

In this study focus is only on internal ring and outer ring Different process by which rings are manufactured is given below.

C. *Turning Section*

Both the inner ring and outer rings are usally machined from the outer and inner races are manufactured from SAE 52 the raw material used in the section has been considered as forged rings.

The turning operations are divided in to various lathe operations,viz.O.D.,face ,track and Bore.All these oprations are done on production lathe machines.These lathe machine offered in the process sequence has to be set before enery new bath is taken up

D. *Heat Treatment*

Hardness is a function of and brittle structure.When slowly quenched it would from Austenite and Parlite which is apartly hard and partly soft Hardening of steel requires a change in structure from the body-centered cubic structure found at room temperature to the face centered cubic structure found in Austenic region.The steel is heated to

Austenic region.when suddenly quenched.the Martensite is formed.This is avery strong extremely slow then it would be most Pearlite,which is extremely soft.

E. Grinding Section

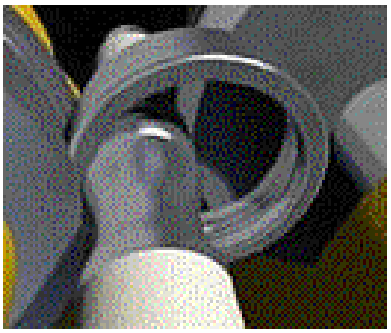


Fig. 3: Track Grinding[3]

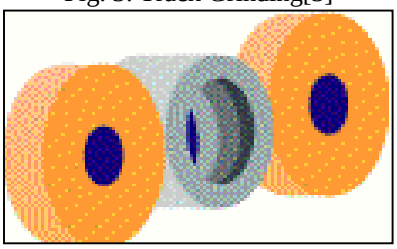


Fig. 4: Grinding the Outer Diameter[4]

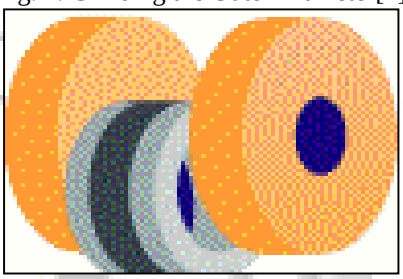


Fig. 5: Face Grinding[5]

The next stage is grinding, in order to give the rings the right form and dimensions. The first operation on inner and outer rings is face grinding. Both faces are ground simultaneously to give the final width Then the outside diameter of the inner rings is ground to the final dimension in centre less grinding machines The final machining operations are carried out on parallel lines of grinding and finishing machines - one for inner and one for outer rings.

Inner rings have the bores and raceways ground, while outer rings have only the raceways ground. This is carried out with form dressed grinding wheels using plunge-grinding techniques.

After honing, the rings are thoroughly washed with a water-based cleaning medium so that they are perfectly clean before assembly ,In-process measurement is common to all grinding machines.

Automatic process control, by means of post-processors, and random checks in specially equipped measuring rooms are also used for additional monitoring of quality

1) Rough O.D. grinding on centre less
2) Face grinding on Rotary table/duplex
3) Bore grinding
4) External track grinding
5) Internal track grinding
6) Finish O.D. grinding

7) 5. Six Sigma Calculation

The term "Six Sigma" comes from process capability studies, which measure the extent to which a process meets customer requirements, specifications, or product tolerances. Sigma represents the standard deviation (variation) from the process mean of a statistical population. Based on the calculation method used in process capability studies, if a process has six standard deviations between the process mean and the nearest specification limit, almost no items will fail to meet specifications. This is a Six Sigma process.

The process capability index is computed using the following formula, where C_p = process capability index, USL = upper specification limit, LSL = lower specification limit, and σ = sigma:

$$C_p = \frac{USL - LSL}{6 \times \sigma}$$

As the equation indicates, higher C_p values are found in more capable processes. As the process standard deviation goes up, or the mean of the process moves away from the center of the tolerance, fewer standard deviations will fit between the mean and the nearest specification limit, thereby decreasing the sigma number and increasing the likelihood of items outside specification.

Numerous process sigma calculators are available on the Internet that provide quick calculation of how a particular process is performing with regard to the Six Sigma goal. The calculation of a sigma level is based on the number of defects per million opportunities (DPMO). The formula to calculate DPMO is:

$$DPMO = \frac{(\text{Number of defects} \times 1{,}000{,}000)}{((\text{Number of opportunities/unit}) \times (\text{Number of units})}$$

(K.Srinivasan[a], S.Muthu[b], N.K.Prasad[c], G.Satheesh)

II. LITERATURE REVIEW

Anup A.Junankar1, Reaserch that In the Belt Manufacturing Industry, main raw material is rubber; others are biased fabric, and cord. From many years consumption of raw material was not taken seriously as rubber is reusable. Operational wastages in the Belt manufacturing process are-top surface rework, printed label rework, cog rework, pin hole rework, fabric rework and other reworks. Out of these rework, fabric rework is observed continuously in REC Belt from past time and it affects the rate of rework. By minimizing fabric rework, rate of production can be maximizing. The scope of our project the minimization of fabric rough problem to reduce the total number of rework.[1]

A. Six Sigma DMAIC Methodology

DMAIC is a closed-loop process that eliminates unproductive steps, often focuses on new measurements, and applied technology for continuous improvement. Implementation of DMAIC Methodology took place in five phases as outlined earlier and established at Motorola. Problem identification and definition takes place in define phase. After identifying main processes, their performance is calculated in measure phase with the help of data collection. Root causes of the problem are found out in analysis phase. Solutions to solve problem and

implementing them are in improve phase. Improvement is maintained in control phase. [1]

Hsiang-Chin Hung and Ming-Hsien Sung Reaserch that The DMAIC (define-measure-analyze-improve-control) approach has been followed here to solve an underlying problem of reducing process variation and the associated high defect rate. This paper explores how a food company in Taiwan can use a systematic and disciplined approach to move towards the goal of Six Sigma quality level. The DMAIC phases are utilized to decrease the defect rate of small custard buns by 70% from the baseline to its entitlement. At the beginning of this project, the defect rate was 0.45% (Baseline), and after the improvement actions were implemented during a six-month period this fell to below 0.141% (goal). The critical successful factors for Six Sigma projects, especially those in the food industry, are discussed at the conclusion of this paper. [2]

B. Define phase

After this project was approved, the champion of this project had to select an appropriate Black Belt and form a Six Sigma team to deal with the improvement. Three tasks must be undertaken during the define phase: Refining feasible project scope, setting up project goals and estimating project hard savings. Because the time period of each Six Sigma project is limited to not longer than six months, a suitable scope for each project is very important if they are to be successfully completed on time. By using a three-layer tree diagram and three Pareto charts, the project scope was narrowed down. The first layer narrow down was to decide what product defect rates should be improved. After the project, scope was specified clearly, various goals needed to be set, namely the project, financial and consequential indices. The project index is also called the primary index, which indicates the measurement and goal of the improvement target based on related time series data.[2]

Miroslav RUSKO, Ruzena KRÁLIKOVA Reaserch that the word "Sigma" is a statistical term that measures how far a given process deviates from perfection as a new methodology using old tools. Six Sigma is a comprehensive system for achieving, maintaining and maximizing business success. The basis of Six Sigma is a detailed knowledge of customer requirements, disciplined use of facts and objective data, statistical analysis and ongoing efforts focused on optimizing business processes.[3]

Six Sigma revolves around a few key concepts:

- Critical to Quality: Attributes most important to the customer;
- Defect: Failing to deliver what the customer wants;
- Process Capability: What your process can deliver;
- Variation: What the customer sees and feels;
- Stable Operations: Ensuring consistent, predict-table processes to improve what the customer sees and feels;
- •Design for Six Sigma: Designing to meet customer needs and process capability.[3]

Diffusion of the watched commodities' parameter can be connected by the commodity itself (deformation, ovality) or the system of measuring. The system of measuring is made by operator, benchmark and the method (the way) of measuring. Measuring System Analysis (MSA) is a tool for the evaluation of accuracy and advisability of the measuring system. It goes with testing (measuring) the chosen parameter by an operator or a group of operators. It monitors the influence of repentance (one operator copies the measuring of the watched commodity's parameter) and reproducibility (group of operators measures the very same parameter) of the total variance. The goal of MSA is to estimate how the system of measuring contributes to the total variance of watched parameter, Fig.1. Most of the time, analysis of the measurement system is used in the phase of Measurements. [3]

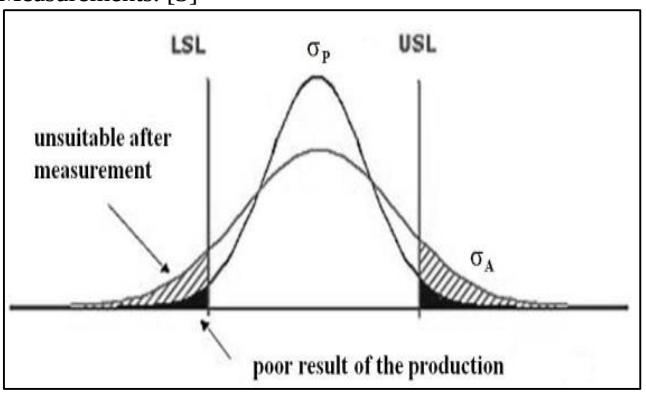


Fig. 6: Measurement System Analysis

Legend: Tolerance = USL – LSL (area of matching values for the customer),
LSL – Lower
Specification Limit, USL - Upper Specification Limit,
σ^2A (absolute) = σ^2P (of product) + σ2 M (of measurement system), σ2 – variance.[3]

Chang-tseh Hsieh Reaserch that the goal of the Analyze Phase is to use data analysis tools and process analysis techniques to identify and verify root causes of the problem. In data analysis, the data that has been collected about the process is used to find patterns, trends, and other differences that can suggest, support, or reject theories about the causes of defects. With process analysis, a detailed look at the existing key processes that supply customer requirements is conducted in order to identify cycle time, rework, downtime, and other steps that don't add value for the customer. One way to help validate or refute these theories is to perform hypothesis testing, or tests of statistical significance. They are some of the most important techniques used by statisticians to look for patterns or test their suspicions about what is really happening in a process and have a number of applications in Six Sigma projects. Figure 3 is a hypothesis testing decision tree which helps to determine the correct statistical test to use based on the type of data (continuous vs. discreet), the type of data distribution (normal vs. non-normal) and the sample size. [4]

Plecko, A.[1] Vujica Herzog N.[2] Polajnar A[3] Reaserch that those who have implemented and practiced six sigma agree that the most important factor for successful implementation of six sigma is top management support and commitment. Managers must be involved in the creation and management of the process management system, and also participate in projects themselves .Six sigma should be part of everybody's job, including top management and senior manager's corporation, business unit or even department managers. Without the top management commitment and support, the true importance of the initiative will be weakened. [5]

Six sigma is a breakthrough management strategy, because it involves adjustments to the firm's values and

culture for its introduction. It also involves substantial change in the organization structure and infrastructure. Usually when important change occurs, the people in the organisation are afraid of the unknown and they do not understand the need for change. Some organization cultures are fear based. Mistakes are not allowed, and employees are used to hiding defects. Six sigma, on the other hand flourishes in an open and safe environment where defects are seen as improvement opportunities [5]

Six sigma organizations develop formal mechanisms to select six sigma projects. These mechanisms involve senior management to filter out six sigma project that do not have financial or strategic implication. From this perspective the decision rights to initiate a project are allocated to senior management. In contrast, other approaches to quality have taken a bottom-up approach where are workers directly involved with the process initiate improvement projects. Giving the management the decision rights to initiate the project helps ensure that project selection is based on strategic importance and not on convenience. [5]

Six sigma uses a structured method for process improvement called DMAIC (define, measure, analyze, improve, and control) method. DMAIC is a closed-loop process that eliminates unproductive steps, often focuses on new measurements, and applies technology. [5]

Tariq Abdowaisan[a], Mustapha Nourelfath[b], Jawad Hassan[a] Reaserch that Gamma and Weibull processes The failure rates for Gamma and Weibull distributions with respect to the Sigma level. The failure rate with respect to the Sigma level for both distributions is affected only by the shape parameter α, and the scale parameter β has no effect. The failure rate for the Weibull distribution is much more sensitive to the value α than the failure rate for the Gamma distribution. These results support our concern that simply reporting the Sigma level as an indication of the quality of a product or process can be misleading. For example, for a quality characteristic that follows the Weibull distribution with shape parameter 3, the failure rate is greater than 25% for a 6 Sigma level of performance. This is Weibull distribution performance that is worse than the 2 parts per billion failure rate for the normal distribution.

ChiaJou Lin[a], F. Frank Chen[b], Hung-da Wan[b], Yuh Min Chen[a], Glenn Kuriger[a] Reaserch that Designs the knowledge retrieval evaluation framework using Six Sigma's Define-Measure-Analyze-Improve-Control (DMAIC) process.

1) Define phase: objective identification
2) Measure phase: performance evaluation
3) Analyze phase: diagnosis
4) Improve phase: revise
5) Control phase: monitoring develops the related technologies to implement the knowledge retrieval evaluation mechanism.

This paper proposes a knowledge retrieval evaluation mechanism which consists of the performance measuring, monitoring and diagnosis to continuously control the quality of the knowledge retrieval process. In order to realize this mechanism, a performance measure, FAveP, is designed, which integrates the F-mean and the Average Precision. Following that, a rule-based reasoning engine is designed that identifies the causes of errors to adjust the knowledge retrieval system accordingly. Finally, an adaptive p-chart is proposed to monitor the performance of the knowledge retrieval system. .

The proposed mechanism allows system developers to maintain the knowledge retrieval system more easily. If the defect rate is over the upper control limit, the evaluation mechanism will trigger the revise function to adjust the knowledge retrieval system to improve the accuracy of knowledge retrieval. Therefore, the knowledge retrieval system will deliver higher accuracy to respond to knowledge requirements, and users will have higher intention to use it. Consequently, knowledge can be transmitted and re-used efficiently through the knowledge retrieval system, which will lead to improved new knowledge creation process. . [5]

Jeroen de Mast n, Joran Lokkerbol Reaserch that their wide adoption in practice warrants a critical scientific analysis. One aspect of a scientific evaluation of Six Sigma is to critically compare its principles with insights from established scientific theories. This work aims to study the Six Sigma DMAIC method from the perspective of scientific theories in the field of problem solving as published in the operations research and management science (OR/MS) and industrial engineering (IE) literatures. Six Sigma is often described as a problem solving methodology, and for that reason, theoretical insights from the problem solving should provide insights on DMAIC. The purpose of the analysis is to identify limitations of the method. These identified limitations may be an inducement for attempts at improving the method. [8]

They start this concluding section by pointing out the most important limitation of this research. In this study, conceive of DMAIC as a problem solving method, and analyze it from that perspective. Study has brought to light some characteristics of problem tasks for which DMAIC may be a suitable method. DMAIC is applicable to empirical problems ranging from well-structured to semi-structured, but not to ill-structured problems or pluralistic messes of subjective problems (people problem solving, in the framework used in the paper). DMAIC is suitable for rather extensive problem solving tasks, requiring all of the components of problem definition, diagnosis, and the design of remedies. It is less suited for problem tasks of a smaller scope. [8]

Chao-Ton Su *, Chia-Jen Chou Reaserch that Six Sigma has been widely adopted in a variety of industries in the world and it has become one of the most important subjects of debate in quality management. Six Sigma is a well-structured methodology that can help a company achieve expected goal through continuous project improvement. Some challenges, however, have emerged with the execution of the Six Sigma. This study aims to develop a novel approach to create critical Six Sigma projects and identify the priority of these projects. Firstly, the projects are created from two aspects, namely, organization's business strategic policies and voice of customer. Secondly, an analytic hierarchy process (AHP) model is implemented to evaluate the benefits of each project and; a hierarchical failure mode effects analysis (FMEA) is also developed to evaluate the risk of each project; and from which the priority of Six Sigma projects can be determined. Finally, based on the project benefits and risk, projects can be defined as Green Belt, Black Belt, or

others types of projects. An empirical case study of semiconductor foundry will be utilized to explore the effectiveness of our proposed approach.

Six Sigma is the most fervent managerial methodology not only in manufacturing area but also in the services industry. Many investigations Six Sigma is the most fervent managerial methodology not only in manufacturing area but also in the services industry. Many investigations have indicated that Six Sigma can increase organization's competitive capability and enhance the quality of products or services by conducting the projects. This study has two advantages. First, a complete procedure from project generation to project mapping is provided which can assist top management in deciding on the critical projects. Second, the proposed approach is without complicated mathematical inference and can be easily implemented. The proposed approach, however, was applied to just one case, the semiconductor foundry service. The generalization of the proposed approach should be further investigated. Moreover, our proposed approach can be employed as a framework to develop computer software for general industrial application in the future.

Khaled Mili[a] Reaserch There are numerous techniques applied in evaluating Six Sigma methodology.

C. The DEMATEL methodology

The DEMATEL method originated for a Science and Human Affairs Program by the Geneva Research Centre of the Battelle Memorial Institute the major application of DEMATEL is to investigate the influential status and strength between the factors and transform them into an explicit structural mode of a system The DEMATEL method has been successfully applied in many fields such as R&D project selection real estate agent service quality expectation ; evaluation of service solutions in service engineering; introduction of a new product ; airline safety measurement ; job performance structuring ; solid waste management ; evaluation and selection of knowledge management strategies; human factors engineering ; developing global managers' competencies ; evaluation of e-learning programs ; hotel service quality , safety and security systems analysis; ; regional development ; strategic planning .

D. The ANP methodology

When Straddle carrier routing problem is evaluated, a group of opinions needs to be collected to know the interdependence relationship among criteria which can be analyzed as a Multi-Criteria Decision Making (MCDM) problem. To improve the quality of decision-making, a methodology is required for selecting the optimal set of ANP goes beyond linear relationships and allows interrelationships among elements. containers to be transported. AHP is a theory of measurement concerned with deriving dominance priorities from paired comparisons of homogenous elements with respect to a common criteria or attribute.

1) Step 1: Developing the decision model structure
2) Step 2: Conducting pairwise comparisons on the clusters
3) Step 3: Super matrix formation and transformation
4) Step 4: Selecting the best alternative

Container terminals continuously seek ways to improve the quality of transportation processes and products and differentiate themselves from their competitors to raise customer satisfaction and revenues. Six Sigma is one of the methodologies utilized in the companies. This study aimed to combine two multi-criteria decision making methods, DEMATEL and ANP to effectively identify the most appropriate transportation plan alternative especially in container terminals. Transportation scheme selection is a complex decision making system composed of goals and sun-systems to better judge differences and interactions which can be referred to a typical multiple decision making criteria application. DEMATEL and ANP techniques are both in conjunction to systematically construct an evaluation model for transportation plan selection.

K.Srinivasan, S.Muthu, N.K.Prasad, G.Satheesh Reaserch that this case study narrowly focuses on reduction/elimination of two imperative responses in spray painting process producing shock absorbers, namely peel off and blisters using the Six Sigma Define-Measure-Analyze-Improve-Control (DMAIC) approach that highly impacts quality at customer end.

Six Sigma is a formal and highly disciplined methodology for reducing process variation to ensure customer satisfaction, cost reduction and profitability of the organization. States that the fundamental plan behind the Six Sigma philosophy is to monitor the process continuously and aims at elimination/reduction of defects or failures from the manufacturing processes.

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