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Lean six sigma implementation in bearing industry

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ABSTRACT

In the current era of competition, organizations are looking for high growth in the business by investing low capital. For greater efficiency in the business, organizations use the lean six sigma (LSS) approach which is data driven methodology to eliminate waste from the process and most practicable nowadays. LSS uses various terminologies for reducing wastes like inventory, transportation, waiting, motion, over processing, waiting and over production. The current research implemented LSS concept in bearing industry by using the define, measure, analyse, improve and control (DMAIC) methodology. DMAIC is stepwise methodology for reducing waste & increase quality. In define phase the problem was define after receiving complaints from users by sight vision in taper roller bearing division. Bore marking issue during inner track honing operation is measure issue of low quality. Use of modified arbour will help industry to improve quality of inner race. The LSS concept was implemented successfully and the sufficient improvement has been made in the product.

Keywords: *Bearing, DMAIC, Lean Six Sigma.*

Introduction

Bearings are very important machine part in various kinds of industries. It is used create relation motion between two parts. The worth of bearings in present time is around 5000 crore in India. Bearings are used mainly in automobile sector and industrial sector. Mainly following type of bearings are manufactured in India such as ball bearing, roller bearing, cylindrical bearing, taper roller bearing and needle roller bearing.

In the current age of manufacturing, India is developing very vastly and various type of industrial engineering concepts are now becoming popular for improving the productivity of the Indian organizations, specially for small and medium enterprises (Mathur et al., 2012). The popular concepts includes six sigma (Meena et al., 2018; Gupta et al., 2018), lean six sigma (Garza-Reyes et al., 2016; Adikorley et al., 2017), work measurement methods (Jain et al., 2016), etc. There is very small amount of research has been done in the bearing industry for improving the effectiveness of organizations. Thus there is need of implementing lean six sigma (LSS) concept in these type of industries to maximize quality and reduce waste.

Toyota production system is main founder of lean manufacturing. Lean manufacturing or lean thinking differentiates values added activities and no value added activities. According to lean, Muda (waste) is anything that adds cost to the product without adding any values.

It comprises of various waste are like set up time, lead time, inventory, rework, scrap material, unnecessary motion, machine downtime etc. The developer of six sigma was Bill smith (Engineer in Motorola) in 1980. Six sigma seeks to find and eliminate defects from manufacturing process, which focus on process output. The mix concepts of lean and six sigma is now gaining more importance (Rodgers et al., 2019) which uses the define, measure, analyse, improve and control (DMAIC) methodology to minimize defects with in the value adding steps in a process. The purpose of this paper is to accomplish a case study on the implementation of LSS for the following objectives:

- To eliminate high amount of rejections.
- To improve product quality.
- To improve productivity by rejection control.

Research Methodology

The research methodology is used to identify, select, process, and analyse information about a specific problem. The below Fig. 1 shows the DMAIC methodology used in the current research work for achieving the various objectives defined in the introduction section.

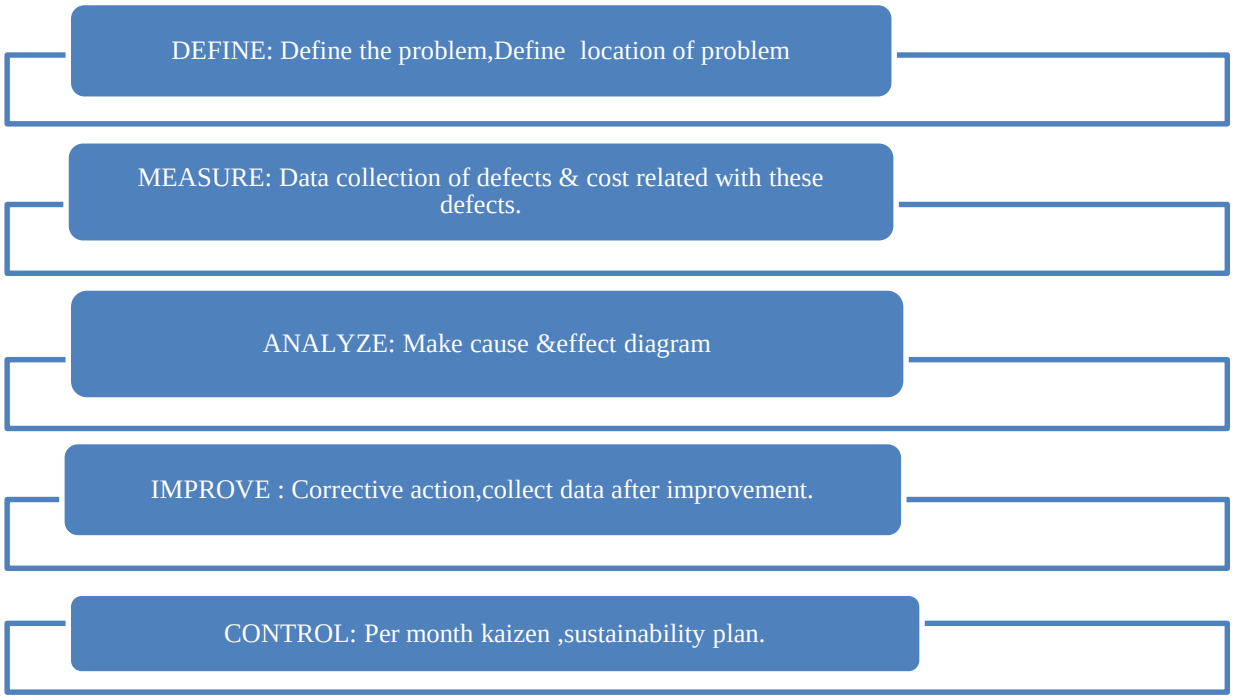

Fig. 1: DMAIC methodology used in current research

DMAIC methodology

1. **Define phase:** A bearing industry suffering from large amount of defects in honing machine during the manufacturing of bearing. In the honing machine, the 'Arbour' is used to locate the inner ring for honing. Due to relative motion between rotating inner and static guiding arbour, lining marks (Fig. 2) are generated at bore of inner ring, which cause poor quality and high rate of rejection.

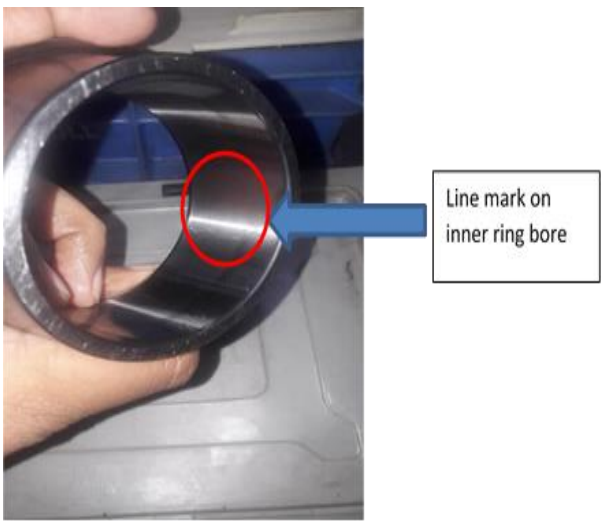

Fig. 2: Problem in ring bore

2. **Measure phase**: In measure phase data were collected for the existing technology used and base line performance of the company which is described below in Table 1.

Table 1: Cost associated for operations

S. No.	Particulars of Operations	Costs of Operations
1	Labour cost per piece	.9 /-
2	Inner race raw material cost per piece	10 /-
3	Primary casting cost per piece	15 /-
4	Manufacturing cost	11 /-
	Total cost per piece	36.9/-
	Total cost of 3300 pieces	1,21,770/-

Table 1 presented the cost of poor quality for one pass which is very high. Company regularly face complaints from the customers about poor quality products which is very harmful for goodwill of the company and to sustain in global market with so many competitors is very difficult.

3. **Analyze phase:** In this phase, the fish bone diagram (cause and effect diagram: Fig. 3) is generated to analyse the cause of these kind of defects with the help of various department of organization (product design, tool design, production).

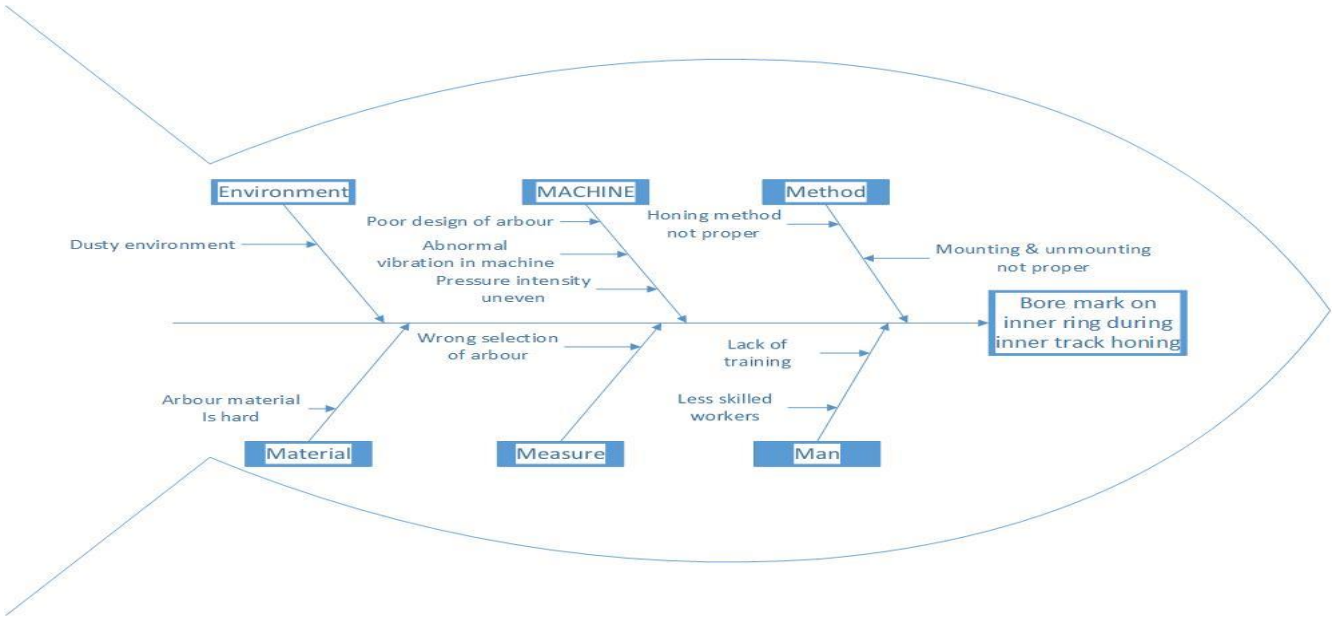

Fig. 3: Root causes identification through fish bone diagram

4. **Improvement phase:** The cause & effect diagram suggested there is need of improvement. The main cause of problem is existing design of arbour is not appropriate for production. The relative motion between rotating inner ring and static guiding arbour is may be the problem. With the help of people from production department, all possible causes were understood and all ideas were noted down for improvement.

Fig. 4: Existing design of Arbour

Corrective action:

Designing of new arbour: The spring arrangements are introduced in the arbour to provide uniform pressure on face of inner ring while rotation. After improvement in design of rotating arbour relative motion generated between the inner ring and rotating arbour is reduced.

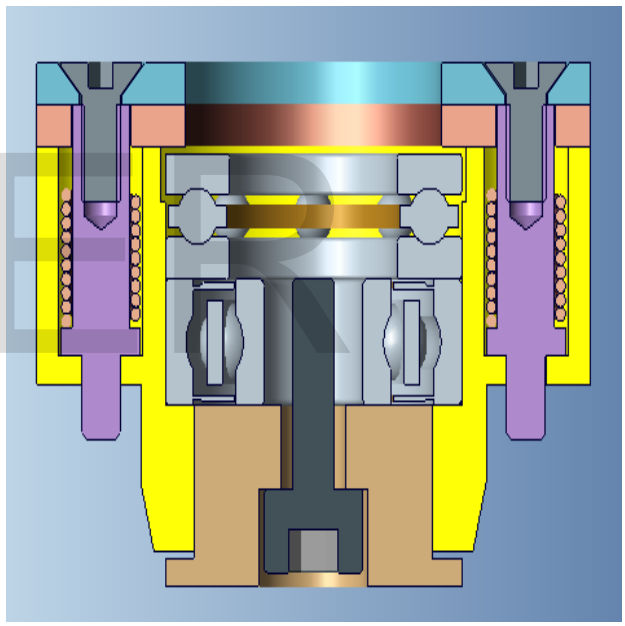

Fig. 5: New design of arbour

5. **Control phase**: Controlling the new changes in any organization is bigger challenge. The outcomes of the improvement are talk over with the various department of organization and to sustain the continuous improvement of the system following actions are taken:
   - Proper maintenance of the machines should be taken timely.
   - Kaizen should be performing at each level of organization and by everyone.
   - Skilled labour should perform the operation
   - Timely trainings should give to the operators.

Result and conclusions:

The problem taken in this project is very critical in the perspectives of quality. The product quality is improved very nicely (Fig. 6). Results are compared before and after using LSS by visual inspection after inner track honing operation. After using DMAIC methodology in bearing industry following benefits were obtained.

- Rejection due to bore marking issue during honing eliminated.
- Improvement in product quality.
- Productivity improvement due to rejection control.

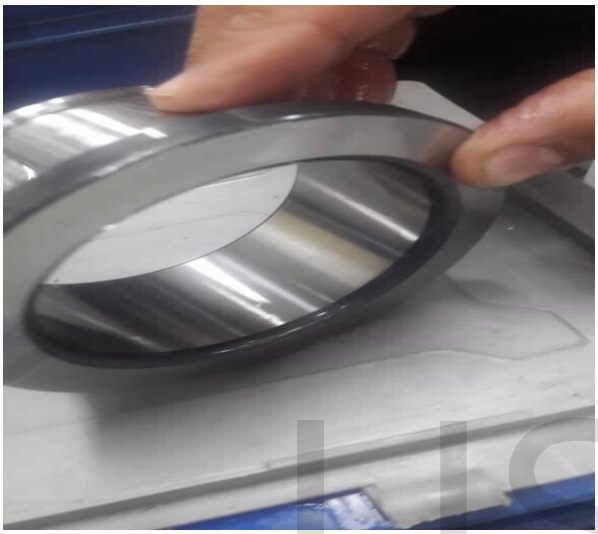

Fig. 6: Improved work piece

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