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Study and Optimization of Defects in Casting Used in Foundry with the Use of Six Sigma Methodology

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Abstract- Casting industries play an important part in the manufacturing industry. Complex form and size goods are created in a single procedure that cannot be produced in other manufacturing methods. Because the other method requires more than one step to transform a raw material into a finished product. The casting's quality should be maintained without flaws throughout production. This is not feasible since we cannot achieve a 100% accuracy rate. However, some quality control instruments and methods may assist to decrease the proportion of faults. The primary goal of this study is to minimize the shrinkage fault that occurs in the External Bearing Ring of ductile cast iron manufactured in Pithampur, Indore's premier casting Renuka factory. From the industry we collect the four months data of production and production defects data in product casting. The data was gathered from the industry over a six-month period, and the flaws were discovered using the Six-Sigma DMAIC (Define, Measure, Analyse, Improve, Control) method. Quality control tools are used at various phases of the DMAIC method to detect and control problems. In addition, the Taguchi method is used to generate the L9 orthogonal array from the Minitab programme. Finally, the optimum solution is developed and recommended to the industry for defect reduction.

Keywords- Casting defects; Six-sigma; DMAIC process; Taguchi; ductile iron.

I. INTRODUCTION

Casting is one of the oldest techniques; dating back to about 4000 B.C. Gold ornaments were manufactured using the casting technique. A few years later, it was used to manufacture weapons and tools using metals such as copper as raw materials. After then, casting was used to create goods with a variety of forms and sizes, as well as various materials such as cast iron and ductile iron. Casting production is important in the area of manufacturing because of its many advantages and requirements. The incidence of casting flaws has a financial impact on the casting business. [1]

Industrial products were manufactured using the casting technique. A few years later, it was used to manufacture weapons and tools using metals such as copper as raw materials. After then, casting was used to create goods with a variety of forms and sizes, as well as various materials such as cast iron and ductile iron. Casting production is important in the area of manufacturing because of its many advantages and requirements. [1]

The incidence of casting flaws has a financial impact on the casting business. As a result, fault incidences should be minimized and casting quality should be increased, which may be accomplished via the employment of methods such as six-sigma and quality tools.

As a result, defect incidences should be minimized and casting quality should be increased, which may be accomplished via the employment of methods such as six-sigma and quality tools. The problem in a specific location is discovered, and modifications are made to minimize the defect. [2]

The External Bearing Ring, which is constructed of ductile cast iron and is one of the major components of the windmill, is examined in this article. The premier casting company in Coimbatore is dealing with a large amount of shrinkage defects on this specific product. With the assistance of Minitab software, shrinkage flaws are minimized using the six-sigma method and quality control tools. [3]

II. SIX SIGMA

Being extremely disciplined, methodical, customer-centric, and profit-driven, or a company-wide strategic business improvement effort that aids in the development and implementation of solutions, products, or services that are really perfect. In a different manner, Six Sigma is attempting to decrease the irregularity of processes that leads to mistakes.

Six Sigma has been seen as a competitive business effort aimed at increasing profitability, market share, and customer satisfaction by using statistical instruments and methods that may result in substantial efficiency gains. Six Sigma is a technique of process and product optimization that combines financial and methodological accounting components.

Many quality assurance efforts, including as bend manufacturing, ISO certification, comprehensive quality management, quality circle, and so on, are undertaken in order to become internationally compatible with and acquire market and organisational excellence sectors. The results of these initiatives, on the other hand, are timely and not so lucrative.

As a result, it is critical to adopt and implement a technique that will develop effectively in such a short time frame. Six Sigma is an acronym that stands for "six is the same method that can provide rapid collapse changes, and it is critical to investigate its use in order to gain efficiency, market share, and customer retention benefits and profits from qualitative analysis.

To achieve Six Sigma accuracy, a process must produce more than 3.4 faults per million chances. A potential of failure is defined as "an opportunity," or failing to comply with the criteria. This implies that our major operations must operate nearly perfectly.

1. Strategy:
- Know what’s Important to the Customer
- Reduce Defects
- Reduce Variation
- Centre around Target

2. Key Concepts of Six Sigma:
At its core, 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

3. Methodology of Six Sigma:
Six Sigma is a stand for "six A sigma, which evaluates a method's ability to achieve flawless efficiency, is also known as a statistical measuring unit. Six sigma is the number of sigma’s computed in either a process where the change around the goal is so high that only 3.4 out of one million outputs become faults or in a process where the entire process now goes up to 1.5 standard deviations over time.

The word "sigma" refers to the spread or dissemination of a process's meaning. Sigma this test determines if the process is capable of producing work that is free of faults. Any mistake causes the customer to be dissatisfied. The sigma value is, in fact, a measure of how well a company process performs. A higher sigma level indicates a lower risk of faults and, as a result, greater performance.

III. RELATED WORKS

According to Ahmad et al (2019) To become globally compatible and to achieve companies and organisational excellence, many product enhancements such as Lean Production, ISO Certification, Total Quality Management, Quality Circle, and others are applied. However, the results of these initiatives were both timely and unprofitable. This entails the development and implementation of a method that may produce significant change in a short period of time. Six Sigma is a similar technique that may provide significant gains in a short period of time, but it is also critical to investigate its use in terms of efficiency, market share, or benefit for quantum advances in customer happiness.

Ahmed et al. (2018) Because of its function as a problem-solving technique, Six Sigma is an excellent tool for helping companies accomplishes their goals. The use of the Six Sigma method in the Egyptian home appliance sector is investigated in this research. The article uses Six Sigma DMAIC techniques to identify and describe systematically the underlying cause (s) of both faults and to offer a dependable strategy for decreasing them (definition, measurement, analysis, improvements, and control). Furthermore, a design of experiment (DOE) and regression analysis enabled the determination of the optimum temperature for both the aluminium molten metal and the increase in the number of flaws.

The research, as well as the statistical study of Six Sigma (DMAIC) technique (DOE and regression analysis), revealed that the aluminium molten metal temperature has a significant impact on defect quantities of aluminium components. After optimising circumstances, aluminium molten metal defects reduced from 10.49 percent to 6.1 percent, and the Six Sigma ratio improved from 2.8 to 3.06 percent. Six Sigma is also thought to have been an effective technique for reducing mistakes and therefore increasing customer satisfaction and cost savings.

Anuj Kumar et al (2017) has been researching a local Haryana foundry business, and the goal of my research is to: 1. Determine the underlying causes of brake drum casting problems. 2. Increase efficiency by lowering brake drum casting flaws. 3. Examine brake drum problems with and without DMAIC. Compare.

Jaykar Tailor and Kinjal Suthar (2017) Six sigma is a quality assurance system. DMAIC Methodology presented research on defect reduction in several areas. Six Sigma techniques and tactics have been used in a variety of industries in recent years in order to improve the efficiency, cost, and variety of final products. Six Sigma emerged as a natural market evolution to increase profit via fault elimination. Six Sigma is a strong business improvement approach that enables companies to define measure, analyse, improve, and manage (DMAIC) processes using simple but powerful mathematical tools. They look at how the DMAIC technique is used in different research articles throughout this article.

Darshana Kishorbhai Dave (2017) DMAIC was used (Defining, Measuring, analysing, improving, controlling). The DMAIC parameters were regulated to reduce both the flaws that occur in castings (Blow holes, metal spreads, surface splits, and irregular layer thickness) and the defects that occur in castings (Blow holes, metal spreads, surface splits, and irregular layer thickness). According to the results, defect-related rejection has reduced from 31.703 percent to 12.82 percent.

Borikar et al. (2017) Casting Part Optimization by Reducing Cold Shut Flaw was a project I worked on. Cold shut was shown to be the primary reason of 80% of refusals. For Cold Shut minimization, the authors utilised a variety of techniques. Due to the gas back pressure, this shortcoming may also be observed in moulds that are not properly vented. Various control tools were responsible for the temperature, phosphorus, and silicon levels. The lowest defect temperature is 1362–1382°C, lowering the Cold Shut to 0.06 percent for the minimum defect between 9% and 5% and the Silicon range between 2.4 and 2.6 percent.

Vivek V. Yadav and Shailesh J. Shaha (2016) A study at the foundry has been presented to reduce casting rejects due to severe flaws. The single cylinder head is a serious issue. The study focuses on blow hole failure studies, which contributes to the total proportion of rejection. To determine the real reasons of the blow holes, the quality analysis necessitates a root cause analysis. Why are analyses employed, and what are the techniques of quality management such as Pareto analysis and the Cause-and-Effect diagram (Ishikawa)?

As a result, corrective and preventative actions are suggested and implemented. Central gas vent cleaning method is included as a control point in the process control check board, and the mounting of wet green sand on the central gas vent during moulds is added as a process enforcement. Evaluations of efficiency after these changes show that blow whole rejection, as well as total rejection, has decreased substantially. Between 7.74 percent and 1.81 percent, the blow whole rejection is negligible. It significantly lowers the gross sales loss and increases output by 8, 60 percent.

Suraj Dhondiram Patil et al (2016) In order to create green sand casting, a research study was carried out. It is being applied to the component transmission case using the Six Sigma methodology. With the Taguchi strategy and the DMAIC technique, it is possible to completely eliminate defects throughout the transmission case. DMAIC stands for "Define-Measure-Analysis-Improve-Control." The project contract, phase map, and cause-and-effect diagram are the most important tools to have on hand throughout the project. Design of experiments (DOE) and analysis of variance (ANOVA) will be used to statistically analyse the connection between faults and mould hardness, green power, and pouring rate, as well as to find the optimal values for reducing/eliminating defects in the cast iron casting process.

The results were statistically evaluated or predicted using Taguchi analysis, which was performed. Experimental work was done with changed process parameters based on the findings and it was discovered that the results were much better than the baseline. The purpose of this article is to differentiate between the current and proposed techniques, and the results are given in great depth in the next section.

IV. DATA COLLECTION

This experimental work Performed in Renuka Industries Pithampur, Indore. External Bearing Hub product is used to manufacturing by foundary in Industry Area.We have collected four months Industrial Production data with its defect’s variations. The main objective of this study is to reduce the amount of shrinkage that happens in the External Bearing Ring of ductile cast iron produced in Pithampur, Indore's finest Renuka casting plant.

Using the Six Sigma DMAIC (Define, Measure, Analyse, Improve, and Control) approach, data from the industry was collected over a six-month period, and the faults were identified using the Six Sigma DMAIC method. A variety of quality control instruments are used at different stages of the DMAIC process in order to identify and control issues.

Apart from that, while generating the L9 orthogonal array from the Minitab software, it is necessary to use the Taguchi technique. Finally, the most optimal solution is created and suggested to the industry in order to reduce the number of defects.

They gather information on the spot. As a result, it is essential to obtain a suitable measurement system prior to the start of the project. Following the identification of issues and possibilities for development, a list of problems was created-

Table 1. Name of casting defects.

S.no	Type of defect
1	Blow holes
2	Slag inclusion
3	Misrun
4	Rough surface
5	Cold shut

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The check sheet is a simple piece of paper that is used to collect data in real time and at the point of production. Typically, the document is a blank form that may be quantitative or qualitative, and allows for the fast, simple, and efficient entry of required information. Rejection check sheets are often large data sheets that describe all of the rejected goods in great detail.

For flaws such as blow holes, misruns, slag inclusions, and rough areas (Table 2), several techniques were employed, and data for each item were previously received from the business, indicating the production and rejection status of the real component (for a given period of time).

Table 2. Detection methods.

S.no	Type of defect	Detection	Appearance
1	Blow holes	Visual method	Rounded holes
2	Slag inclusion	Visual method	Pitted surface
3	Misrun	Visual method	Unfilled cavity
4	Rough surface	Touching method	Rough surface

The statistics for the total pouring per month for the last four months is shown below. The following table 3 shows bearing hub rejection.

Table 3. Data collection (before improvement).

Month	Production	Rejection	Blow hole	Slag inclusion	Misrun	Rough surface
Dec 2020	8515	521	188	172	84	77
Jan 2021	8576	545	189	186	92	78
Feb 2021	8498	536	186	178	96	76
March 2021	8527	552	187	184	98	83
Total	34116	2154	750	720	370	314

Total production of four month = 34116

Total rejection = 2154

Rejection % = (2154/34116)* 100 = 6.31 %

Table 4. Total rejection data (before improvement)

Defects	No. of defective piece	Percentage of rejection
Blowhole	750	34.81 %
Slag inclusion	720	33.42 %
Misrun	370	17.16 %
Rough surface	314	14.57 %

To graphically represent the percentage rejection and bar chart was used. Percentage rejection of casting defect based on last 4 months.

1. Calculation of Present Sigma Level:
Utilizing defect per million opportunities (DPMO) technique they will compute their current sigma level the with equation presented below.

$$\text{DPMO} = \frac{\text{No. of defects x 1000000}}{\text{No. of opportunities x no. of units produced}}$$

The defects per unit (DPU) are:
DPU = Total number of defects observed in the batch /Total number of units produced in the batch. Rejections were only affected in this scenario because of the blow holes. Any other options for refusal really aren't taken into account. Therefore, there is one possibility.

Hence, defects per opportunities (DPO) are:

DPO= DPU/1

By the same token, defects per million opportunities (DPMO) are:

DPMO = DPO×1,000,000

The sigma quality level with ± 1.5 σ shift is determined by the equation:

$$\boldsymbol{Sigmaqualitylevel} = \mathbf{0.8406 + \sqrt{29.37 - 2.221\, X \ln (DPMO)}}$$

DPU= 2154/34116 = 0.06313
DPO = 0.06313/1 = 0.06313
DPMO = 0.06313 x 1000000 = 63137.53

$$\boldsymbol{Sigmaqualitylevel} = \mathbf{0.8406 + \sqrt{29.37 - 2.221 \text{ x } \ln (63137.53)} = 3.03}$$

Table 5. Sigma level for 4 months.

Current Sigma Level Calculation	
Total no. of units produced	**34116**
Total defects	2154
No. of opportunities	1
DPMO	63137.53
Existing sigma level	3.03

2. Analyse Phase:
The goal of this procedure is to figure out what's causing the problem and what's causing the CTQ. During this phase, many techniques and technologies are utilised to determine the few most significant reasons to monitor in order to enhance process efficiency.

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3. Pareto Chart:
The Pareto diagram indicates the cumulative number of Y-axis defects and the nature of the X-axis error. By 80-20 Rule, the critical defects can indeed be identified in the diagram.

The analysis results below show the principal defects that contribute to the main percentage refusal.

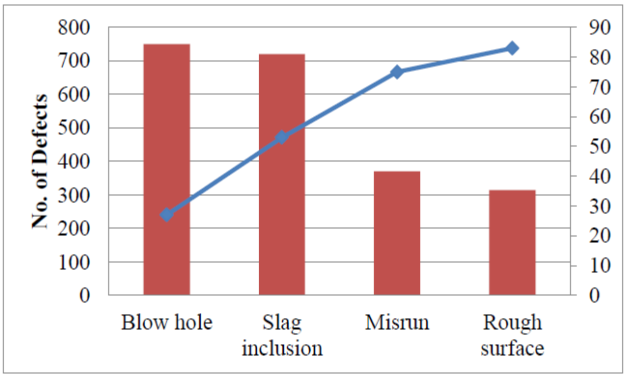

Fig 1. Pareto chart of bearing hub for last four months.

One of the four major flaws was identified as a blow hole. It was crucial to figure out the precise causes of the blow-hole failure in order to figure out why the Ishikawa diagram was misapplied in the first place.

V. RESULTS AND DISCUSSION

1. Analysis of Variance:
ANOVA is a statistical method for comparing differences between the means of two or more populations. Experiments were carried out to this aim, utilising ANOVA to estimate the significance of the input parameter for almost every response element. The parameter that has the greatest impact on the outcome is probably the most significant. A 95 percent confidence interval was used in research.

2. ANOVA Analysis for Blow Holes Defect:
Table1 displays the ANOVA findings of the experiments. The F value calculated by the MINITAB 15 software in the second last column of the ANOVA table shows the significance of the factors on their intended characteristics. The higher the F value, the more significant it is (considering confidence level of 95 percent).

Table 6. ANOVA for blow hole defect.

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Pouring Temperature (°C)	2	5.6296	5.6296	2.8148	3.36	0.055
Silica sand %	2	6.3519	6.3519	3.1759	3.79	0.040
Error	2	16.740	16.740	0.8370		
Total	8	28.721				
S = 0.914897	R-Sq = 67.15 %		R-Sq (adj) = 57.30 %			

The P value of the pouring temperature and silica sand is less than 0.05, indicating that they have a substantial effect on the rejection percent. It's also worth noting that P is 0.055, which, since it's so close to 0.05, might be considered a significant factor.

3. Main Effect Plots for Blow Holes Defect:
Each parameter's optimum level must be determined. Figure 1 shows the primary impact plot, which was created to determine the optimum degree of these factors.

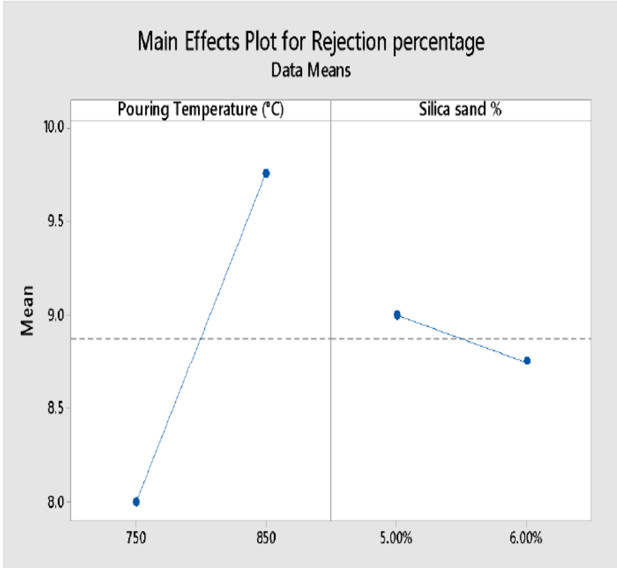

Fig 2. Main effect plot for % rejection.

4. Determination of Optimum Solution:
From the above chart we conclude that following parameters are the best from the rejection point of view:

Table 7. Optimum levels.

Parameter designation	Process parameters	Optimal levels
A	Pouring Temperature (°C)	750
B	Silica sand %	6

***5.* Confirmation Test:**
After settling on optimum levels, that one was reviewed with management in order to acquire confirmation permission for all three criteria. After obtaining authorization, the following optimal degree experiment was carried out.

6. Improvement in Blow Holes Defects:
The validation process was successful at both parameters at the optimum level and these parameters are set to just that level as well as the increase of the refuse shown in Table 8 was determined after this data collection.

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Table 8. Data collection of rejection after improvement for blow holes.

Parameter set	Pouring Temperature = 750 °C	Silica sand = 6 %	% Rejection
No. of Batches	Total Production	Total Rejection	
1	480	25	5.2
2	500	19	3.8
3	440	21	4.77
4	485	16	3.29
5	527	24	4.55
Total	2432	105	

Total production = 2432

Total rejection = 105

Rejection % of blow holes defects = (105/2432) * 100 = 4.31%

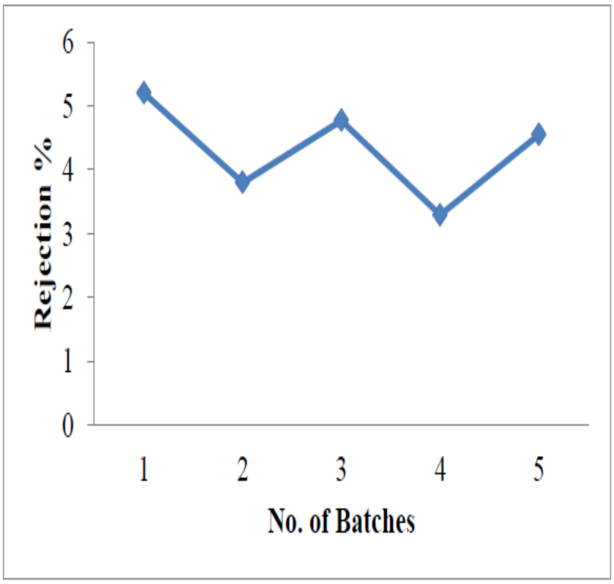

Fig. 3: Rejection trend of blow holes defect after study.

7. Improvement in Slag Defects:

Slag defects were caused by rough ladle lining or skimming metal. As a result, some new equipment, which the company had never utilized before the process, was employed to remove the slag inclusion fault.

- Slag defects also reduced material up to 2 percent by adding slax-30 (foseco data foundry manual pp. 229).
- Clean ladle to use.

The company data has again been compiled after such improvements have been made.

Table 9. Data collection of rejection after improvement for slag inclusion.

Parameter set	Pouring Temperature = 750 °C	Silica sand = 6 %	% Rejection
No. of Batches	Total Production	Total Rejection	
1	533	18	3.38
2	477	22	4.61
3	527	17	3.23
4	483	18	3.73
5	512	22	4.30
Total	2532	97	

Total production = 2532

Total rejection = 97

Rejection % of slag inclusion defects = (97/2532)* 100 = 3.83 %

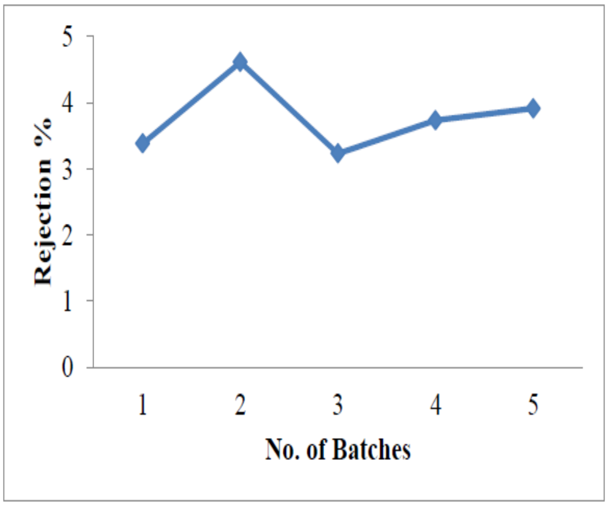

Fig 4. Rejection trend of slag inclusion defect after study.

8. Improvement in Misrun Defects:

The fundamental causes of Misrun deficits have been identified as core change and low flow times. The surface fault temperature has been eliminated as a result of the improvement and core change management. As a result, further measures to strengthen this flaw have been implemented.

- By introducing 0.2 to 0.3 % flux (lime stone), faults were reduced. 1. 1.
- Chaplets used it to reduce Misrun faults in order to avoid key shifts.

After implementation of these improvements, the data of the company was collected again.

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Table 10. Data collection of rejection after improvement for misrun defect.

Parameter set	Pouring Temperature = 750 °C	Silica sand = 6 %	% Rejection
No. of Batches	Total Production	Total Rejection	
1	546	21	3.85
2	485	19	3.92
3	533	22	4.13
4	487	23	4.72
5	530	17	3.21
Total	2581	102	

Total production = 2581

Total rejection = 107

Rejection % of slag inclusion defects = (102/2581)* 100 = 3.95 %

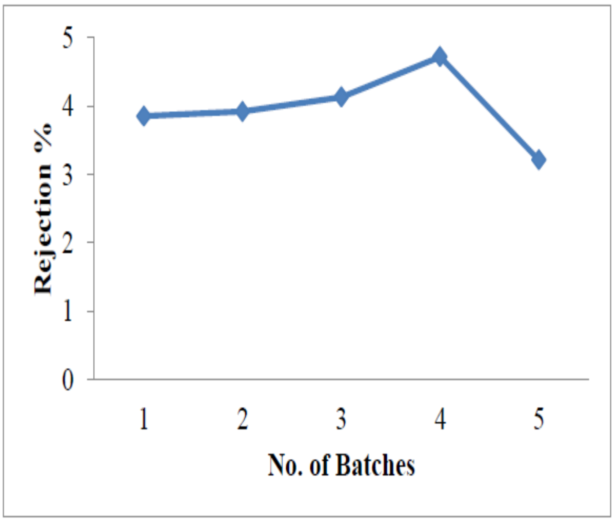

Fig 5. Rejection trend of misrun defect after study.

9. Improvement in Rough Surface Defects:

Improper patterns and loose rolling were found to be the underlying causes of raw surface defects, and therefore the pattern coating and loose rolling were eliminated, which had a significant impact on the flaws.

As a consequence, several of the rough surface flaws have undergone certain modifications.

- The added carbon dust of 0.9 percent to 1.1 percent increased the soft ramming.
- The pattern was applied with varnish coating.
- Zirconium paste coating of the inside of the mould.
- The company data has been compiled after such changes have been made.

Table 11. Data collection of rejection after improvement for rough surface defect

Parameter set	Pouring Temperature = 750 °C	Silica sand = 6 %	% Rejection
No. of Batches	Total Production	Total Rejection	
1	536	19	3.54
2	510	22	4.31
3	496	20	4.03
4	530	17	3.21
5	487	21	4.31
Total	2559	99	

Total production = 2599

Total rejection = 99

Rejection % of slag inclusion defects = (99/2599)* 100 = 3.8 %

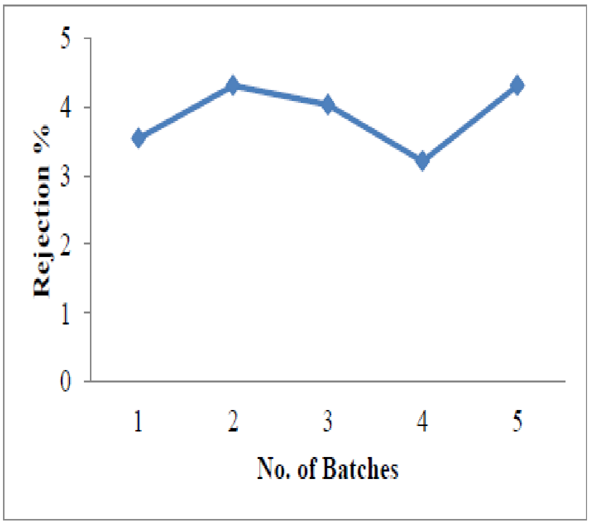

Fig 6. Rejection trend of rough surface defect after study.

10. Calculation Of Sigma Level After Study:

The current sigma level is evaluated and the results equation even by Defect per Million Opportunities (DPMO) method:

$$\text{DPMO} = \frac{\text{No. of defects x 1000000}}{\text{No. of opportunities x no. of units produced}}$$

The defects per unit (DPU) are:

DPU = Total number of defects observed in the batch /Total number of units produced in the batch

Total no. of defects = 105 + 97 + 102 + 99 = 403

Total units produced = 2432 + 2532 + 2581 + 2559 = 10104

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DPU = 403/10104 = 0.03988

In this case, rejections due to defects are only concerned. Any other opportunities for rejection are not accounted. Hence, the number of opportunities is 2.

Hence, defects per opportunities (DPO) are:

$$\textbf{DPO} = \textbf{DPU}/2 = \mathbf{0.019943}$$

By the same token, defects per million opportunities (DPMO) are:

$$\textbf{DPMO} = \textbf{DPO} \times 1{,}000{,}000 = 0.019943 \times 1{,}000{,}000 = 19942.6$$

The sigma quality level with ± 1.5 σ shift is determined by the equation:

$$Sigmaqualitylevel = 0.8406 + \sqrt{29.37 - 2.221\ X\ \ln(DPMO)}$$

$$Sigmaqualitylevel = 0.8406 + \sqrt{29.37 - 2.221\ X\ \ln(19942.6)} = 3.55$$

11. Cost Analysis:
The rejection time is decreased and expenses are significantly lowered (in terms of profit). The costs are analysed in Table 12.

Table 12. Cost analysis of bearing hub.

Sr. no	Product	Cost @Rs 28 Kg/wt	Previous rejection cost	After implementation Rejection cost
1	Bearing hub	10.4 Kg/ Rs. 291.2	2154 x 291.2= Rs. 6,27,245	403 x 291.2 = Rs. 1,17,354

12. Productivity Improvement:
Productivity analysis has been carried out as shown below;

Table 13. Productivity improvement before and after.

	Rejection	Percent saving	Total Production	Defective item	Good item	Productivity
Before	6.31 %	3.69 %	34116	2154	31962	93.6 %
After	3.98 %		10104	403	9700	96 %

As per above study we found the productivity improvement analysis with improvement in percentage rejection and found equal percentage saving with improvement in productivity.

VI. CONCLUSION

Specifically, they examine the potential of Six Sigma in Indian small and medium-sized companies in their research thesis. Six Sigma deployments in small and medium-sized enterprises (SMEs) is a new quality improvement paradigm that has been embraced by many academics. The goal of the research is to implement the Six Sigma roadmap in SMEs, which are typically thought to exist only in big corporations. This case study will serve as an inspiration for Indian SMEs to embark on activities that would assist in the expansion of their businesses.

As part of this thesis, a case study from the Pressure Die Casting industry is presented, which shows how Six Sigma may be used to produce dramatic gains in both process and business efficiency. The pressurised die casting process has undergone changes that the industry was completely unaware of. The DMAIC technique was used to reduce the amount of rejection of a casting product known as the bear hub during the testing process.

From the experiment following conclusions were drawn.

- This case study demonstrates how the DMAIC methodology was effectively implemented. DMAIC was hailed as a game-changing method for increasing product and process efficiency.
- Management's average performance has improved.
- Pouring temperature was set to 750°C, while silica sand content was set at 6%.
- In this case study, the efficiency of pressure drop dead was improved by lowering the reject rate from 6.31 to 3.98 percent and increasing the benefit by 2 lakh from 3.03 to 3.55.
- Pouring temperature and silica sand have a P value of less than 0.05, indicating that they have a substantial impact on percent rejection. The pour temperature's P value is 0.055, which is a significant factor since it is so close to 0.05. It's also worth noting that it's a P value.
- Reduced moisture and improved sand permeability from 34.81 percent to 4.31 percent were used to decrease flaws in blow holes.
- Because of slag flaws, the rejection rate was reduced by 33.42 percent to 3.83 percent.
- Rejection due to faults via Misrun was reduced from 17.16 percent to 3.95 percent by utilising chaplets.
- The use of coal dust reduces rugged-surface fault rejections from 14, 57 percent to 3, and 8 percent.
- If these results are achieved, senior management in the industry is persuaded that they should begin this study, but they have decided to focus on Six Sigma initiatives for their other operations. They will profit more from such initiatives if Six Sigma is linked to the company's strategic strategy.
- From 93.6 percent to 96 percent, productivity rises.

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VII. FUTURE SCOPE

Six Sigma will be regarded by a variety of sectors that seek to enhance corporate excellence and efficient marketing as a result of amazing achievements in many organisations. A game-changing approach will increase efficiency, competitiveness, and profitability tenfold. Because of its versatility, it may be used to enhance any product, process, or transaction.

Six Sigma is a customer retention strategy that enables a business to retain its workers by delivering high-quality products and services. By using Six Sigma, they may be able to reduce flaws in all processes or produce goods that are near to their goals. This approach has the potential to increase efficiency, productivity, profit, market share, and customer loyalty.

- It is possible to do research on other foundries.
- To attain high quality, Lean's current supply chain management method may be utilised.
- JIT and Kaizen will compare and combine findings in order to enhance quality.
- Combine the DMAIC solution with Taguchi's quality optimization technique.

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