Reduction of Failure of Molds in Foundry Shop by Using DMAIC Methodology – A Review

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ABSTRACT

Today manufacturing industries facing a great challenge because of increasing global competition. Nowadays many industries uses DMAIC methodology of six sigma to overcome this challenge. DMAIC is powerful philosophy of six sigma used for improving processes or products at lowest possible cost. In this study, DMAIC methodology is implemented in Foundry shop to improve process by reducing various casting defects. Here DMAIC methodology used as defect reduction technique during casting in foundry to produce defect free molds. During this various types of casting defects are identified and their various root causes. In current scenario of globalization, foundry performance should be high as foundry play a vital role in manufacturing industry because they are major sources of castings. The aim of this study is to produce defect free molds which are prepared in foundry shop by castings through reduction of various casting defects by DMAIC methodology of six sigma. At last this study provides an knowledge of casting defects and their various root causes. This also results sufficient saving on foundry expenses which occur during molds preparation in foundry shop and finally we get defect molds.

Keywords: DMAIC, Casting defects, Six Sigma, Molds, Foundry

INTRODUCTION

Industries are highly conscious in current scenario of globalization to face competition. For this industries took appropriate steps to be competitive in market. To be competitive in market, many researchers provide several tools and techniques, but one of the best technique is DMAIC**. (Darshak et al.,2006)** applied DMAIC methodology for increasing the satisfaction level of customers in small enterprises.

Nowadays DMAIC is practiced as philosophical process and also practiced as method to enhance the quality by reducing various types of defects. This is powerful strategy of six sigma which increases the production efficiency of industries. This methodology reduces the variations in product or processes and also detect and remove wastage **(Kumar et al.,2011a).**

Companies have to maintain this powerful methodology for fulfilling the demands of customer. By using DMAIC methodology, companies can review the process which already exist and take corrective action for improving the process. It also used for defining the project, measuring, analyzing and improving the project with the help of various tools and techniques.

Tools and Techniques used for implementation of DMAIC methodology
There are various tools and techniques are used for implementation of six sigma in any project. One of the distinctive approach of six sigma is DMAIC which improves the quality of products **(Garza et al.,2010)**
Some tools used for implementation of DMAIC for improving the process are:

- For finding the major defects- Pareto chart
- For managing the data where it generated – Check sheets
- For analyzing a problem- Cause and effect diagram
- For presenting the data in form of bar- Histogram
- For establishing the relation between two sets of variables- Scatter plot

- For checking the process is in control or out of control – Control charts
- For defining a problem in sequence manner – Flow chart

Some techniques used for implementation of DMAIC are : Brainstorming, Kaizen , Voice of customer, Bench marking and Stream mapping.

Steps taken in implementing DMAIC methodology
DMAIC improves the product or process which already exists. It is considered as road map for enhancing the processes **(Kwak and Anbari,2006)**

PHASES OF DMAIC

(Dale et al.,2007) define phases of DMAIC as given below :

i) Define: In this problem is defined and it mainly focus on voice of customer.

ii) Measure: It measure the various parameter of process which causes variations.

iii) Analyze: It focus on finding the input variables which causes variations in output of process. It is generally a forward step to achieve sigma level in process.

iv) Improve: In this various correction action or plans set up for defined problem to achieve excellence . In this ,we identify various ways for improving the process.

v) Control: It is final phase of DMAIC methodology in which improvements done in previous phases are sustained in well manner.

LITERATURE REVIEW ON DMAIC

Kakaei-Lafdani et al.(2021)applied DMAIC approach while producing spiral welded pipes which are used for transmission of gas and water.

Kaushik P et al.,(2009) used DMAIC approach for reducing de-mineralized water usage in Power Plant.

Soundararajan K. and Janardhan Reddy K.(2019) used DMAIC methodology for reducing the cost and improving the quality in SMEs.

M.L Meena et al.,(2018)used DMAIC approach for improvement in process through reduction of defects in automotive part manufacturing company.

Ilesanmi Daniyan et al.(2022)used DMAIC approach for improving the assembly process of rail car bogie by increasing its efficiency.

Panagiotis Tsarouhas(2020) used DMAIC approach in industry of bag production. In this DMAIC methodology is used for reducing the downtime of bag production line.

HewanTayeBeyene(2016) used DMAIC approach for reducing the defects in sewing section at Garment and Textile factory.

Chandrasekhar Sunil More et al.,(2017) used application of Six Sigma DMAIC in minimization of dent in gear manufacturing.

SelvarajS(2021) used DMAIC approach for reducing the rejection rate of starter motor shaft assembly in automobile industry.

Anupama Prashar (2014) used DMAIC methodology for decreasing the quality costs. This paper study find chronic problems related to failure of fan assembly in repair section of company.

Problem Formulation

In present work, DMAIC methodology applied in foundry shop to reduce the failure of molds. Today many manufacturing company facing the problem of defected molds in foundry due to various casting defects. This also results financial loss to company. To overcome this problem, DMAIC methodology is applied in foundry for reducing the casting defects and increasing the efficiency of foundry.

Objectives Of Study

The objective of this study is to increasing the efficiency of foundry   by reducing the failure of molds with the application of DMAIC.

The main objectives of implementation of DMAIC methodology in foundry are as follows :

- To improve the efficiency of foundry shop through reduction of various casting defects.
- To remove the casting defects for getting defect free molds.
- To find the factors which are responsible for rising various casting defects.

The present study deals with reduction of casting defects to get defect free molds in foundry with the help of various statistical tools. The objective of this study is to decrease the casting defects which arise in foundry during preparation of molds.

RESEARCH METHODOLOGY– DMAIC

This methodology is used in foundry shop to produce defect free molds through reduction of various casting defects.
There are various casting defects found during casting which are reduced by many researchers (**Bhupinder Singh, 2014**) in foundry shop which are responsible for producing defects molds are :

a) Blow holes: These defects appears as cavities in casting. These are not visible from outside because it generally outside occur below the surface of castings.

b) Gas porosity: It arise during solidification of metal. If liquid metal absorb gases, gases will be out during solidification because of decreasing solubility which create voids.

c) Misran defect: It arise due to improper filling of metal by metal.

d)Shrinkage : It arise due to solidification of metal. In this casting defect, volume shrinkage occur. To avoid this, proper feeding of material is required.

e) Surface roughness: It is also called surface defect in casting. In this streaky lines appear in pattern of line and forming small channels due to molten metal flow.

f) Slag inclusion: Slag is major cause of slag inclusion. To avoid this, flux is used to remove oxide and impurities present on metal during melting process.

g) Metal penetration: These arise when molten metal enter the space between grains of sand. This hold sand grains tightly.

Dmaic In Foundry Shop

Castings' rejection rate is a major issue in Indian foundry (**Binu Bose et al.,2013**). This issue in casting produce defected mold in foundry.

To overcome this problem, DMAIC procedure is implemented in foundry shop for reducing the percentage rate of failure of molds as discussed below:

Define phase : In this phase, casting process is observed to identify the factors which are responsible for casting defects which further lead to production of defected molds in foundry. In this phase, various casting defects are described which need to removed. For this casting process should be monitored continuously. Some casting defects found during casting which lead to failure of molds in foundry are : Blow hole, Gas porosity, Shrinkage, Slag inclusion, Misran, Surface roughness & metal penetration.

Measure phase: This phase identify the defects which need to be removed (**Omachonu et al., 2004**) to reduce the percentage rate of failure of molds. In this phase we also find the percentage rejection of molds after collecting data for particular time. This phase measure the process with the help of measurement system using various set of standards which are predefined.

Analyze phase: In this phase, we find the causes responsible for producing casting defects and their effect on the process through a cause diagram and effect.

Improve phase: After finding the causes of defects, solution are achieved in this phase. This phase focus on removing causes which are defined by previous phases.

Some improvement done during this phase for removing defects in foundry are :

a) Improvement in blow hole defect: Blow hole defect arise due to high clay content which further leads to high moisture. To avoid this , clay content test is done in foundry to determine the composition of sand. At last silica sand is added for lowering moisture.

b) Improvement in surface roughness: For this, proper pattern coating should be done

c) Improvement in slag inclusion defect: For avoiding this, some materials are added

d) Improvement in misran defect: Maintain proper pouring temperature.

e) Improvement in metal penetration defect: Grain fineness number test is done for determining the fineness of grains of molding sand. For avoiding this defect, finer grain size of sand is much needed.

Control Phase: This phase control the process and maintain the improvements which achieved in previous phases of DMAIC in well manner. It also compare the range of data to find the process is in control or out of control by making control charts.

RESULTS AND CONCLUSION

The conclusion from this study is that improvement in process can be done by implementing DMAIC methodology. In this study DMAIC methodology is implemented in foundry shop to produce defect free molds in foundry through reduction of various casting defects. At last, after proper implementation of DMAIC methodology we find percentage rate of rejection of molds decreased. This means DMAIC methodology successfully implemented in foundry shop.

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