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IMPLEMENTATION OF STATISTICAL TOOLS AND TECHNIQUES IN TO MANUFACTURING SECTOR-A BRIEF ANALYSIS OF SUITABLE TOOLS AND TECHNIQUES

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ABSTRACT

The manufacturing sector has always been a cornerstone of economic growth, driving innovation, efficiency, and productivity. This made me think in the research of implementation of these statistical tools and techniques in to manufacturing sector speciously which are the tools we can try to implement towards bringing in to interface between the statistical tools to the manufacturing. Since the literature studies and researches till now being notice very rare part of statistical tools being added or used in this sector. So, here in the current study we have picked several tools like SIPOC diagram, Control chart and Brain Storming methos as a initial tools and techniques in briefing the how we can synchronise the interface this tools to the manufacturing. The statistical tools and techniques that can be effectivelyimplementedinthemanufacturingsectortooptimizeprocesses, reduce variability, and enhance product quality. The paper also discusses the relevance and application of these tools in addressing common challenges within the industry.

KEYWORDS: *Statistical Tools, SIPOC, Control Charts, Brain Storming*

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INTRODUCTION

The manufacturing sector is characterized by complex processes that require careful monitoring and control to ensure consistency and quality in production. As manufacturing processes become more intricate, the need for advanced statistical tools and techniques has grown significantly. These tools help manufacturers analyze data, identify patterns, and make informed decisions that can lead to improvements in efficiency, cost reduction, and quality enhancement.

As it's a known fact that the production and production planning and controlling of the gears, especially the spur gears are being a very difficult task so it's a bit being a critical issue towards the design, development and production of spur gears are to be taken under consideration and this element has to be considered severely for a better sustainability in the competitive market conditions now a days.

Statistical tools and techniques are essential in identifying the root causes of variability in manufacturing processes, optimizing production parameters, and ensuring that products meet stringent quality standards. This paper explores various statistical tools and techniques that are particularly suitable for the manufacturing sector, providing a brief analysis of their implementation and benefits.

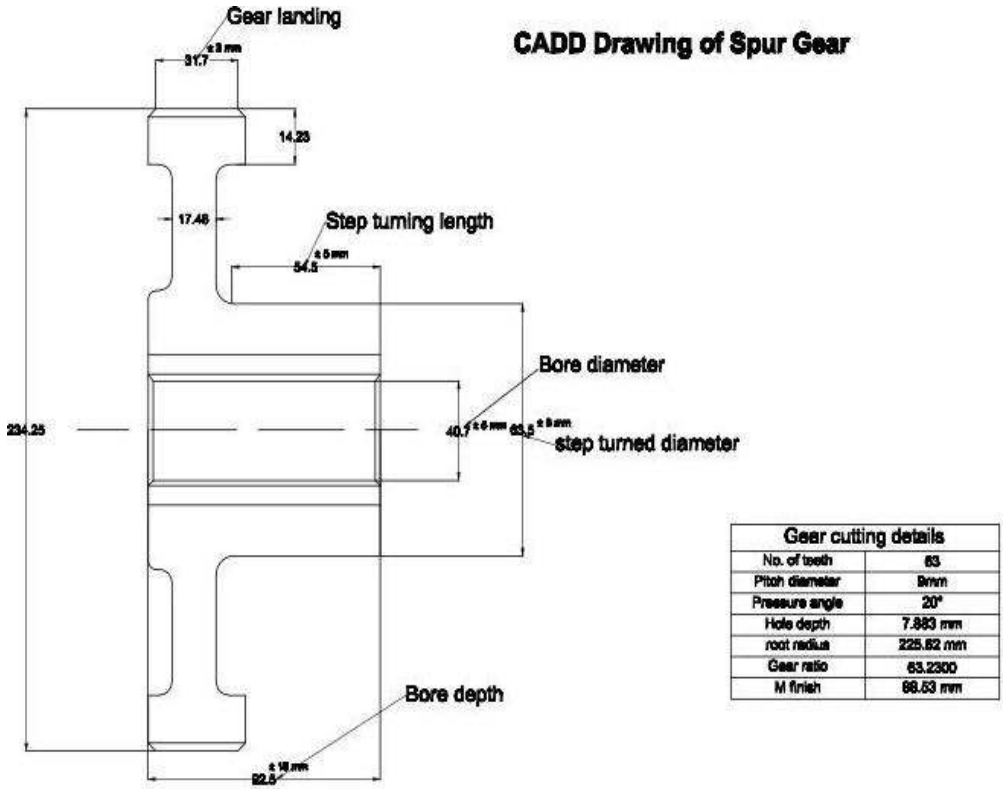


Figure 1: CAD Drawing of Spur Gear.

History of the Problem

Spur gears or straight cut gears are the simplest type of gear. They consist of a cylinder or disk with the teeth projecting radial and although they are not straight-sided in form, the edge of each tooth is straight and aligned parallely along rotational axis. These gears can be meshed together correctly only if they are fitted to parallel shafts. These spur gears are used as driver gear in Bombay lathe.

A sample gear is as shown in figure below

Figure 3.01: Gearafter Machining

Figure 3.1 shows the spur gear after completion of machining operations such as step turning, boring and chamfering and which is ready for teeth cutting.

Statistical Tools and Techniques in Manufacturing

1. SIPOC diagram
2. Brain Storming
3. Cause & effect analysis

SIPOC Diagram

SIPOC stands for Suppliers, Inputs, Process, Outputs, and Customers. It is a high-level visual tool that provides a comprehensive overview of a process, mapping out its key components from start to finish.

Brainstorming

Brainstorming is a creative problem-solving technique that involves generating a wide range of ideas in a group setting, with the goal of identifying innovative solutions to a specific problem.

Cause & Effect Analysis(Fishbone Diagram)

Cause & Effect Analysis, also known as a Fish bone Diagram or Ishikawa Diagram, is a tool used to identify the root causes of a problem. It categorizes potential causes into major categories, such as People, Process, Equipment, Materials, Environment, and Management.

LITERATURE REVIEW

The survey of literature is so carried to know about the previous discussions and research work carried out on minimizing the defects related to gears and gear manufacturing, also by adapting TQM tools and techniques including Lean Manufacturing like DMAIC as a major part in the current work.

Below is the survey of literature article with the author names and the brief of their research work details:

Sameer Kumar et.al [1] studies set out to highlight how a leading manufacturer of tooling with its continuous improvement drive has leveraged DMAIC Six Sigma potential to realize cost savings and improved quality on their shop floor. The study examines one of a crucial quality issues in shop floor dealing with finding a way to reduce the amount of warp incurred in Amada Station punches during the heat-treat process. And the goal of study is utilizing Six Sigma tools namely, brainstorming, process mapping, fish-bone diagrams, histograms, and control charts. The analysis resulted in several findings and recommendations. A major contributor to the warp was the method used to fix the parts. Also identified that, adapting a new fixture to hang the parts, the amount of warp could be greatly reduced. The major recommendation was that the new heat-treat fixture design be implemented as soon as a reliable fixture design has been proven. The significance of implementing advanced fixture design estimates roughly about $10,000 yearly savings, which is because of elimination of a secondary grinding operation and elimination of scrap parts.

Matthew Franchetti et.al [2] studied the DMAIC, Six Sigma approach along an euphoria quantified a significant value-stream analysis towards reducing costs by capacity increasing in local manufacturing entity in North-west Ohio, USA. The DMAIC approach and case study demonstrated a broad application and how an organization can significantly reduce costs. The journal specifies every level along DMAIC cycle including Six Sigma tools thus being applied, including a rigorous value mapping technique and develops a framework that being implied as template in reducing cost and capacity enhancement training. The DMAIC approach and case study demonstrated a broad application and how an organization can significantly reduce costs.

CONCLUSION

From the literature review, it can be concluded as the previous observations and studies depict a clear verdict about choosing the current study and for forming the problem statement, also the various tools and techniques employed in achieving the target out comes with an ease of identification and selecting methodologies to reach the ultimate target.

Objectives of Work

1. To verify the feasible of statistical tools and techniques implementation towards the manufacturability
2. To identify the best suitable statistical tools and techniques which can be implemented in study
3. To appropriateness are the correctness to the extent to which the statistical tools can justify in minimization of the defects

SIPOC Diagram

1. Definition and Purpose

SIPOC stands for Suppliers, Inputs, Process, Outputs, and Customers. It is a high-level visual tool that provides a comprehensive overview of a process, mapping out its key components from start to finish.

Purpose: The SIPOC diagram is used to define and understand the scope of a process, identify key elements involved, and ensure alignment between different stakeholders.

Table: SIPOC Diagram

Supplier	Input	Process	Output	Customer
Casted component (s g iron) from k.k. foundry	Casted Component	Step turning to remove sand particles	Sand free component	Preparing for step turning
Preparatory for step turning	Sand free Casted Component	Step turning	Step turned component	Preparing for drilling hole
Preparatory for drilling hole	Step turned Component	Drilling the hole	Drilled component	Preparing for boring
Preparatory for boring	Drilled component	Boring the already drilled Hole	Bored component	Preparing for gear cutting
Preparatory for gear teeth	Bored component	Gear Ariel hobbing	Gear having required teeth	Preparing for inspection
Preparatory for grinding of teethes	spur gear	Grinding	spur gear	Preparing for inspection
Preparatory for inspection	Grinded spur gear	Inspection by measuring instruments	Inspected spur gear	Preparing for packing and delivery to customers

1. Application in Manufacturing

In the manufacturing sector, SIPOC diagrams are used to map out entire production processes, from the acquisition of raw materials (Suppliers) to the delivery of finished goods (Customers). Ithelpsinidentifyingcrucialinputsthataffecttheprocessandoutputsthatneed to meet specific quality standards.

Example: In an automotive manufacturing plant, a SIPOC diagram might be used to map the assembly process, identifying critical suppliers (e.g., parts manufacturers), inputs (e.g., raw materials), the assembly process, outputs (e.g., completed vehicles), and customers (e.g., dealerships).

2. Benefits

Clarity: SIPOC diagrams provide a clear understanding of the process, highlighting areas where issues may arise or where improvements can be made.

Alignment: By defining the process elements, SIPOC ensures that all stakeholders have a shared understanding of the process, which is crucial for successful process improvement initiatives.

Targets will achieve as per timeline Rework is minimised

As defects minimize and wastage is minimizing ultimately the expenses are saved. Ultimately the productivity was increase in indirect way

Brainstorming

1. Definition and Purpose

Brainstorming is a creative problem-solving technique that involves generating a widerange of ideas in a group setting, with the goal of identifying innovative solutions to a specific problem.

Purpose: The primary purpose of brainstorming is to encourage free thinking and idea generation, allowing for diverse perspectives and the exploration of various solutions.

2. Application in Manufacturing

In the manufacturing sector, brainstorming sessions are often used to tackle complex problems, such as reducing waste, improving efficiency, or addressing quality issues. It is particularly useful in the early stages of process improvement initiatives, where diverse input is valuable.

Example: A brainstorming session might be held to identify ways to reduce down time on a production line. Participants might suggest ideas ranging from preventive maintenance to process redesign, which can then be further evaluated.

Benefits

Creativity: Brainstorming encourages out-of-the-box thinking, which can lead to innovative solutions that might not have been considered through traditional methods.

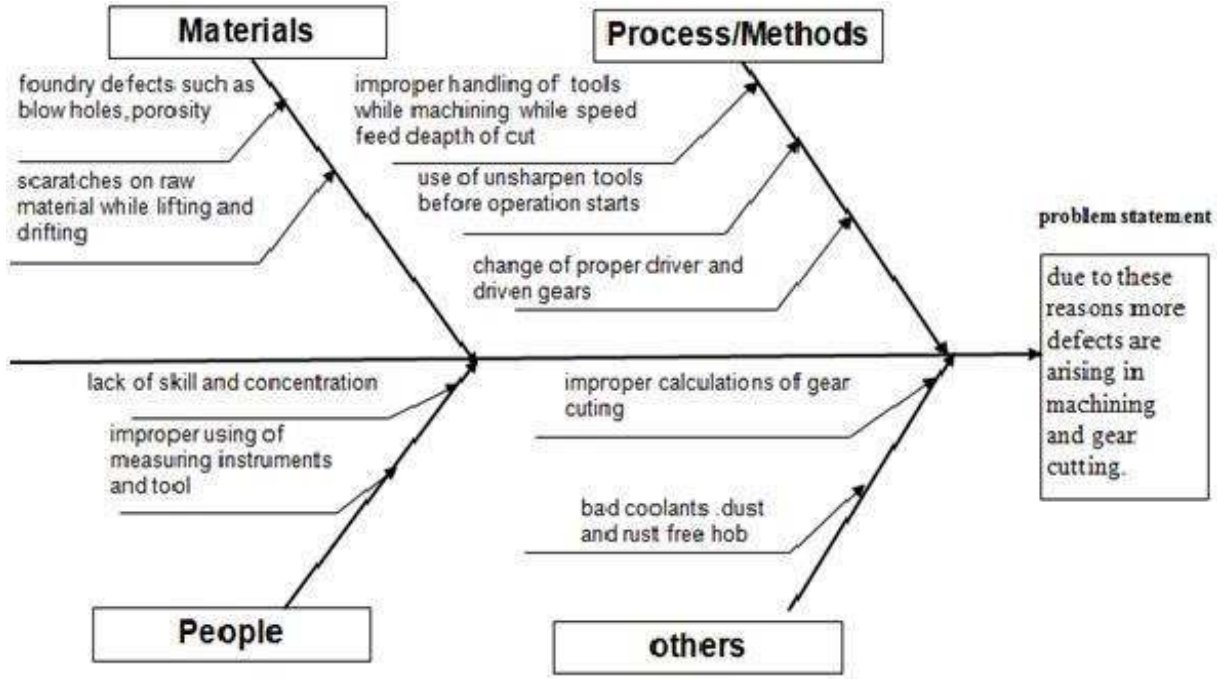
Collaboration: It fosters collaboration among team members, leveraging their collective knowledge and experience to address challenges.

Cause & Effect Analysis(Fishbone Diagram)

1. Definition and Purpose

Cause & Effect Analysis, also known as a Fishbone Diagram or Ishikawa Diagram, is a tool used to identify the root causes of a problem. It categorizes potential causes into major categories, such as People, Process, Equipment, Materials, Environment, and Management.

Purpose: The purpose of Cause & Effect Analysis is to systematically explore all possible causes of a problem, leading to a better understanding and more effective solutions.



1. Application in Manufacturing

In manufacturing, the Fishbone Diagram is widely used to investigate quality issues, defects, or inefficiencies. By categorizing potential causes, it helps teams focus on specific areas for further investigation.

Example: If a manufacturing plant is experiencing high defect rates, a Cause & Effect Analysis might reveal that the issue stems from outdated machinery (Equipment), insufficient training (People), or poor-quality raw materials (Materials).

2. Benefits

Structured Analysis: The Fishbone Diagram provides a structured approach to problem- solving, ensuring that all potential causes are considered.

Root Cause Identification: By focusing on the root causes, rather than symptoms, this tool helps in implementing long-term solutions that prevent recurrence of the problem.

Processing of Data for Analysis(Type of Analysis)

The Cost Analysis: defines the extent of loss by the defects occurred through cost analysis. While machining spur gears types of defects occurred are shown through SIPOC diagram and cause and effects analysis.

Table: Cost details of Spur Gear Manufacturing

1.	Cost of raw material per gear	1250Rs
2.	Raw material cost of 22 gears	27500 Rs
3.	Loss due to 5 gears rejected while machining	26500 Rs
4.	Gear cutting cost /gear	513 Rs
5.	Gear cutting cost of 17 gears	8721 Rs
6.	Loss due to gears returned due to gear cutting defects	15900 Rs
7.	Recycling cost /gear	630 Rs
8.	Recycling cost of 8 gears	5040 Rs
9.	Recovery cost= cost of number of raw materials recovered-recycling Cost	4960 Rs
10.	Loss=cost of number of gears rejected -recovery cost	37440 Rs

Challenges and Considerations

While tools like SIPOC diagrams, Brainstorming, and Cause & Effect Analysis are highly effective, their success depends on accurate data, skilled facilitation, and a collaborative approach. Moreover, the integration of these tools into existing processes may require cultural shifts and training within the organization. Additionally, the success of these tools relies on accurate data collection and interpretation, as well as a commitment to continuous improvement.

Conclusion

With this research study it can be concluded as the statistical tools are best suitable and feasible towards minimising defects, downtime and choosing a best method to improve the productivity as an indirect strength as observed in the case study of applying this methods on a gear manufacturability especially thus executed.

We can conclude that the application of statistical tools and techniques in the manufacturing sector is crucial for achieving operational excellence, maintaining quality standards, and staying competitive in the global market. By leveraging tools such as SIPOC diagram, Brain Storming and Cause & effect analysis. While challenges exist, the benefits of implementing these tools far outweigh the difficulties, making them indispensable in modern manufacturing.

REFERENCES

1. *Montgomery,D.C.(2019).IntroductiontoStatisticalQualityControl(8thed.). Wiley.*
2. *Antony, J., & Banuelas, R. (2002). Key ingredients for the effective implementation of Six Sigma program. Measuring Business Excellence, 6(4), 20-27.*
3. *Box,G.E.,Hunter,W.G.,&Hunter,J.S.(2005).StatisticsforExperimenters:Design, Innovation, and Discovery (2nd ed.). Wiley.*
4. *Pyzdek,T.,&Keller,P.(2014).TheSixSigmaHandbook(4thed.).McGraw-Hill Education.*
5. *Ishikawa,K. (1982).Guide toQualityControl.AsianProductivityOrganization.*
6. *Tague,N. R.(2004).TheQualityToolbox(2nded.).ASQ QualityPress.*

7. *Brassard,M.,&Ritter,D.(2010).TheMemoryJogger2:ToolsforContinuousImprovement and Effective Planning (2nd ed.). GOAL/QPC.*

8. *Juran, J. M., & Godfrey, A. B. (1999).Juran's Quality Handbook (5th ed.). McGraw-HillEducation.*