PROJECT REPORT ON

PROCESS QUALITY MANAGEMENT

in making of Aluminium Candle Stand

SUBMITTED BY:

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PROBLEM DEFINITION

C. L. Gupta Exports Ltd. is a private company which deals in the manufacturing and export of decorative handicraft items. They manufacture various handicrafts in metal (aluminium, steel, brass, and copper) , Wood, Glass, Stone and Ceramic. One of these handicrafts is an Aluminium Candle Stand.

This product is in high demand and different type of defects occur in its manufacturing. So company needs to focus on reducing the no. of defects occurring in these candle stands to meet their customers' expectations. The company is aiming to achieve a lesser rejection rate which will be possible only if the defects (or defective) frequency can be reduced. Therefore, the problem identified here is the reduction of defects(or defectives) to improve the performance level of the manufacturing process for C. L. Gupta Exports Ltd.

OBJECTIVE

To reduce the average rate of rejections or defectives in each process that is included in manufacturing of Aluminium Candle Stand.

HOW DO WE ACHIEVE THAT ?

- *Identifying the root cause of major defects.*
- *Suggestions and recommendations to the company based on analysis done.*
- *Calculating the improvement level and maintaining it.*

COMPANY

C. L. Gupta Exports Ltd.

ABOUT COMPANY

C. L. Gupta Exports Ltd. is a private enterprise, established in 1965.
The company deals in manufacturing and export of handicrafts. The company has a manufacturing facility spread across approximately 55 acres of land, with a vertically integrated production facility of materials such as

- Wood,
- Metal (aluminium, steel, brass, and copper)
- Glass,
- Stone and
- Ceramic.

Through consistent performance, C.L. Gupta Exports Ltd. has received various awards for being a top exporter in the craft.

ADDRESS:

C. L. Gupta Export Ltd. 18Km. Stone, Delhi Road, Vill. Jivai, near Moradabad, Uttar Pradesh 244221

WEBSITE:

https://clgupta.com/

TOTAL QUALITY MANAGEMENT

Total quality management describes a management approach to long–term success through customer satisfaction. In a TQM effort, all members of an organization participate in improving processes, products, services, and the culture in which they work. One of the core concepts of TQM which can be used to drive the process of continuous improvement and to develop a framework for quality improvement over many years is all work is process which is one of the focal point of improvement because a process is a combination of methods, materials, manpower and machines that work together to produce a product or service. In order to achieve customer satisfaction thorough better product quality, we can apply one of the majorly used TQM initiative, which is Six sigma

SIX SIGMA

Six Sigma is a widely practiced, systematic and structured methodology embedded with statistical methods and managerial philosophies for quality improvement . Six Sigma is a set of techniques and tools to improve the capability and reduce defects in any process.

METHODOLOGIES / TECHNIQUES USED

- **DMAIC (an acronym for Define, Measure, Analyze, Improve and Control)** refers to a data-driven improvement cycle used for improving, optimizing and stabilizing business processes and designs. The DMAIC improvement cycle is the core tool used to drive Six Sigma projects

- **SIPOC (an acronym that stands for Suppliers, Inputs, Process, Outputs, and Customers)** The SIPOC diagram is fairly common among business process experts as a logical way of looking at a process in terms of a series of steps; that converts an input into an output. Inputs come from suppliers, and the outputs go to customers. It helps clearly understand the purpose and the scope of a process.

- **P CHART** is an attribute control chart used when plotting:
  i) DEFECTIVES
  ii) VARIABLE SAMPLE SIZE
  This chart is used to develop an upper control limit and lower control limit (UCL/LCL) and monitor process performance over time. It plots the number of defectives per unit sampled in a variable sized sample.

- **PARETO CHART** is one of the key tools used in total quality management and six sigma methodologies. It is basically a bar chart showing how much each cause contributes to an outcome or effect. In quality terms, 80 percent of the losses come from 20 percent of the causes.

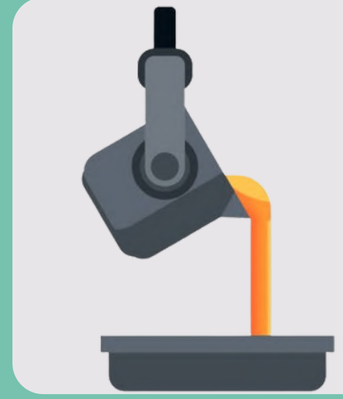
- **AHP** (an acronym for analytic hierarchy process) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. It provides a framework for needed decisions by quantifying its criteria and alternative options and relating those elements to overall goals.
- **CAUSE AND EFFECT DIAGRAM** examines why something happened or might happen by organizing potential causes into smaller categories. It can also be useful for showing relationships between contributing factors. One of the Seven Basic Tools of Quality, it is often referred to as a fishbone diagram or Ishikawa diagram.

PROCESS FLOW CHART

RAW MATERIAL (ALUMINIUM)

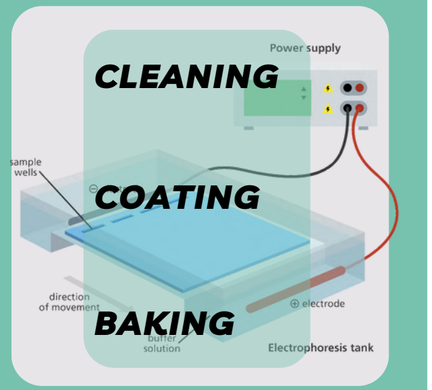
MELTING

PRESSURE DIE CASTING



POLISHING

ELECTROPHORETIC LACQUERING



FINISHED PRODUCT

OUR FLOW FOR ALL STAGES

D

DEFINE

- *Problem specification & identification*
- *SIPOC Diagram*

M

MEASURE

- *Data collection*
- *Baseline process perfomance measurement*
- *Control charts*
- *Pareto analysis*

A

ANALYZE

- *Using cause & effect analysis*
- *Root causes*

I

IMPROVE

- *Analyze all root causes & identify improvement possiblities*
- *Implement improvement trials*

C

CONTROL

- *Standardizing of corrective methods*
- *Continuous performance monitoring*

STAGE 1

Stage 1 comprises two primary processes: Melting and Pressure Die Casting. This stage is fundamental for transforming raw aluminium into the desired form for further shaping and refinement.

MELTING

PRESSURE DIE CASTING

SIPOC DIAGRAM:

SUPPLIER

- *Raw aluminium supplier*
- *Mould supplier*
- *Tools & equipment supplier*
- *Manpower & experience*

INPUTS

- *Raw aluminium*
- *Energy (Electricity, Fuel)*
- *Moulding machine*
- *Mould design and specifications*
- *Operating instructions*
- *Quality Standards*

PROCESS

- *Melting Aluminium*
- *Mould preparation*
- *Pressure Die Casting*
- *Cooling*
- *Mould opening and ejection*
- *Trimming*

OUTPUT

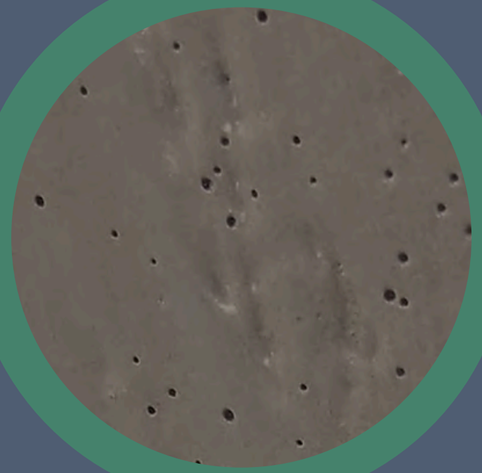
- *Shaped Candle Stand Component*

CUSTOMER

- *Next process: Polishing*

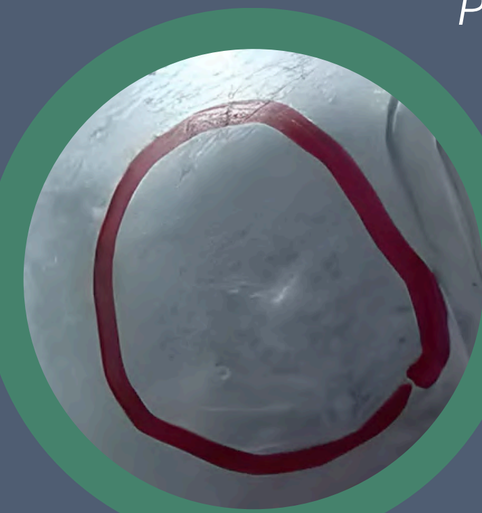
DEFECTS:

NON FILLING

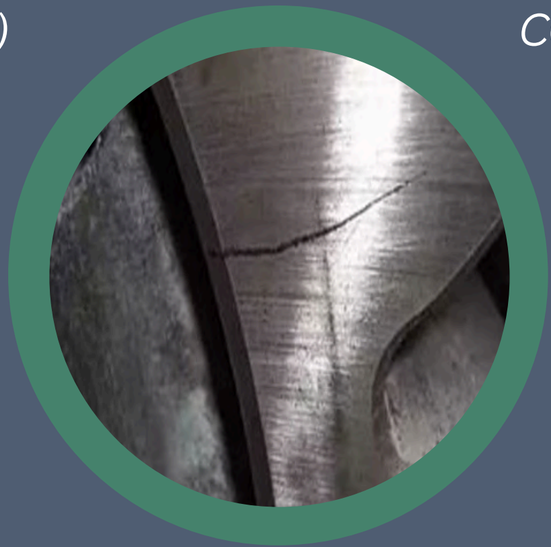


PIN HOLES (“खासर”)

COLD SHOT

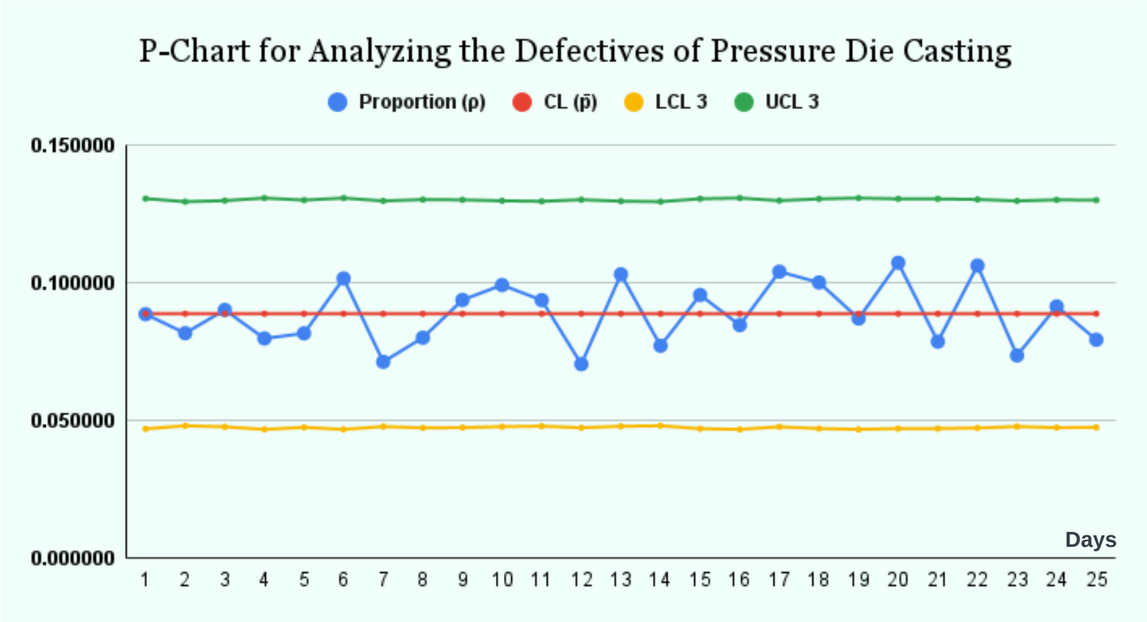


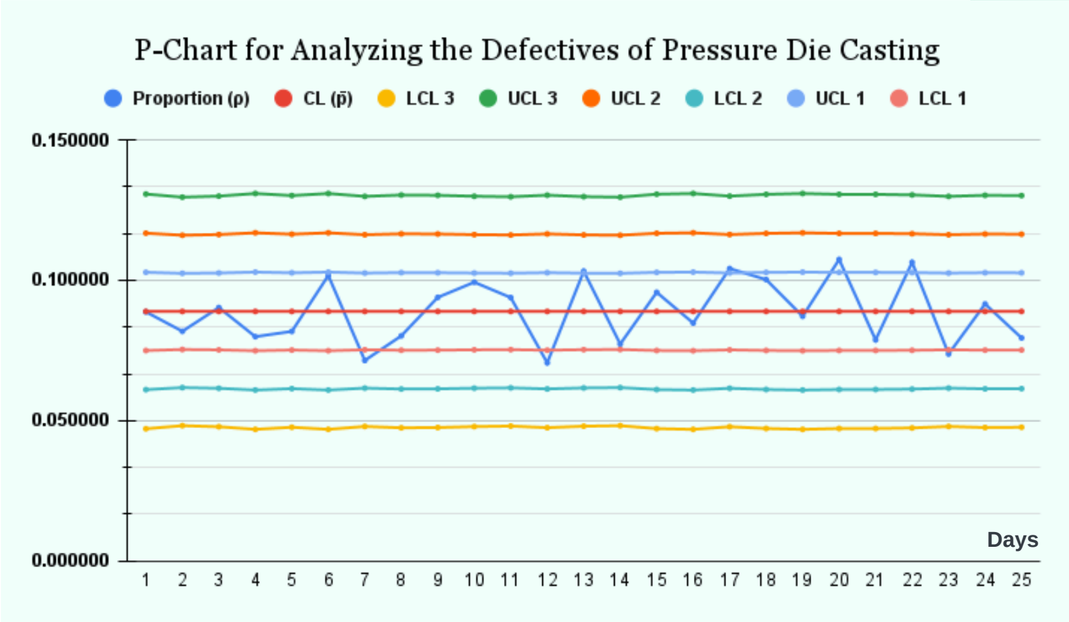
DENT



CRACK

MEASURE:

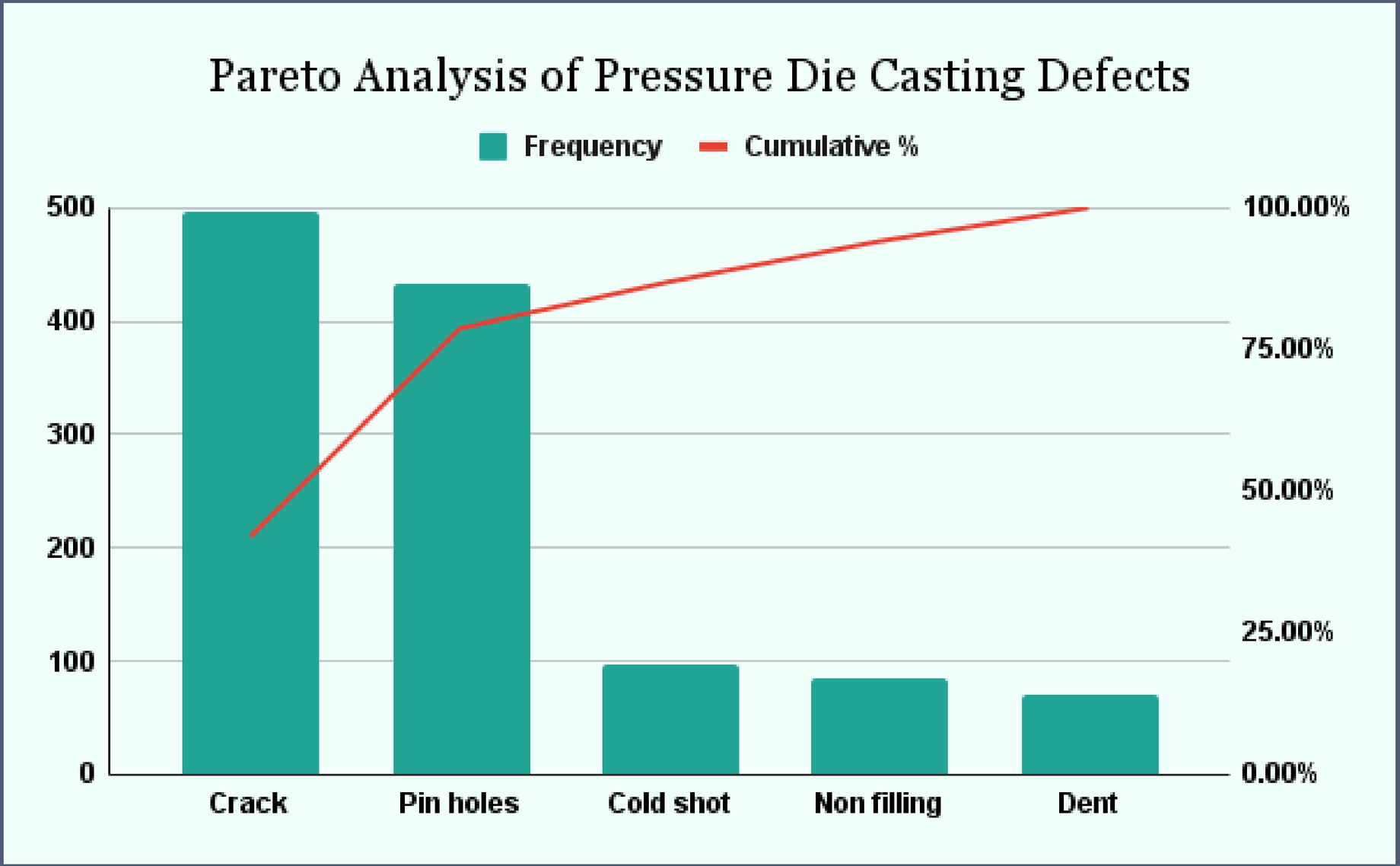




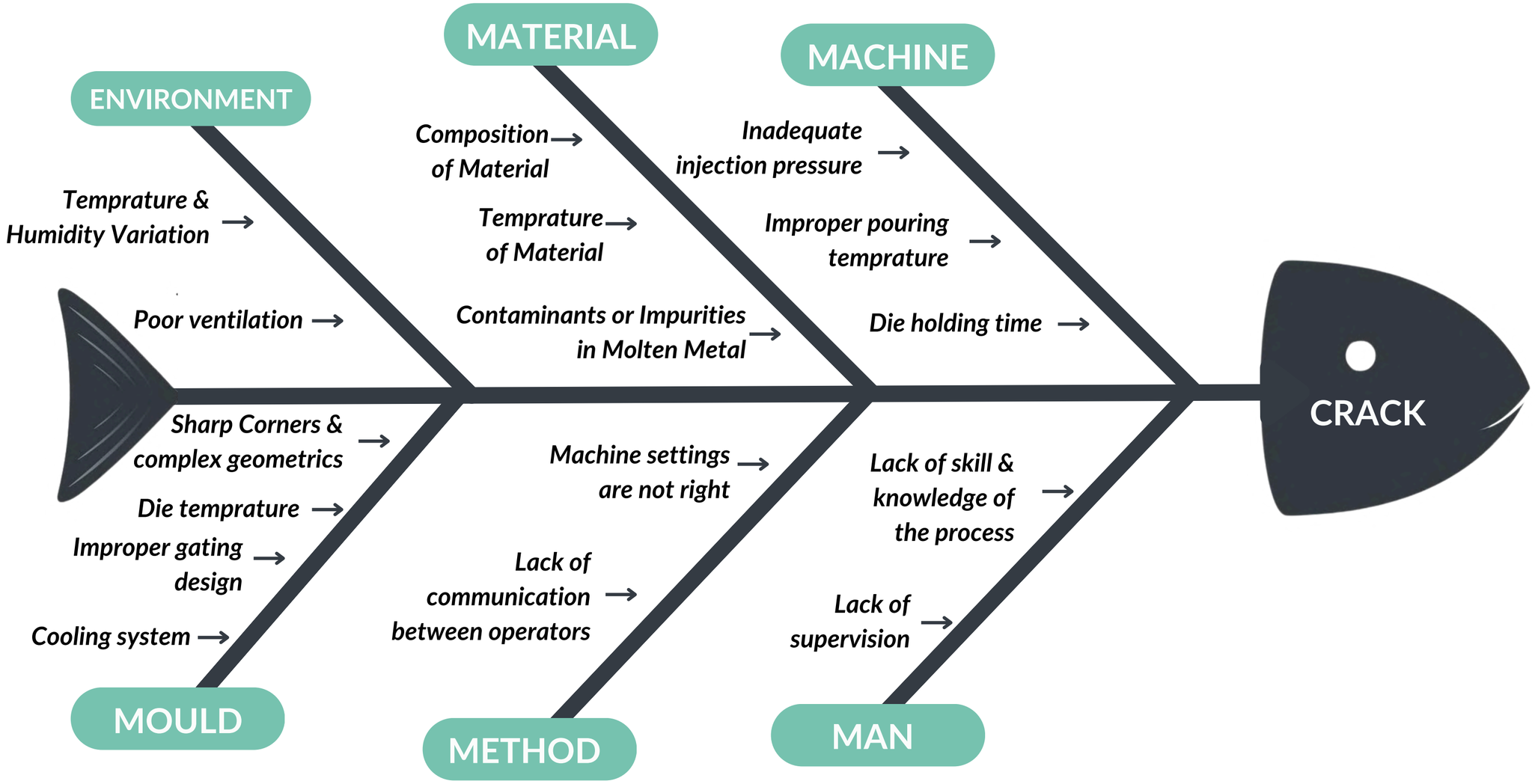
Defectives	946
Opportunities	5
Total Units	10642
Total Opportunities	53210

DPU	0.08889306521
DPO	0.01777861304
DPMO	17778.61304
Yield	98.2221387
Sigma Value	3.601954904

ANALYSE :


Pareto Analysis of Pressure Die Casting Defects
Frequency
Cumulative %
500
400
300
200
100
0
100.00%
75.00%
50.00%
25.00%
0.00%
Crack
Pin holes
Cold shot
Non filling
Dent

CAUSE & EFFECT DIAGRAM OF CRACK :



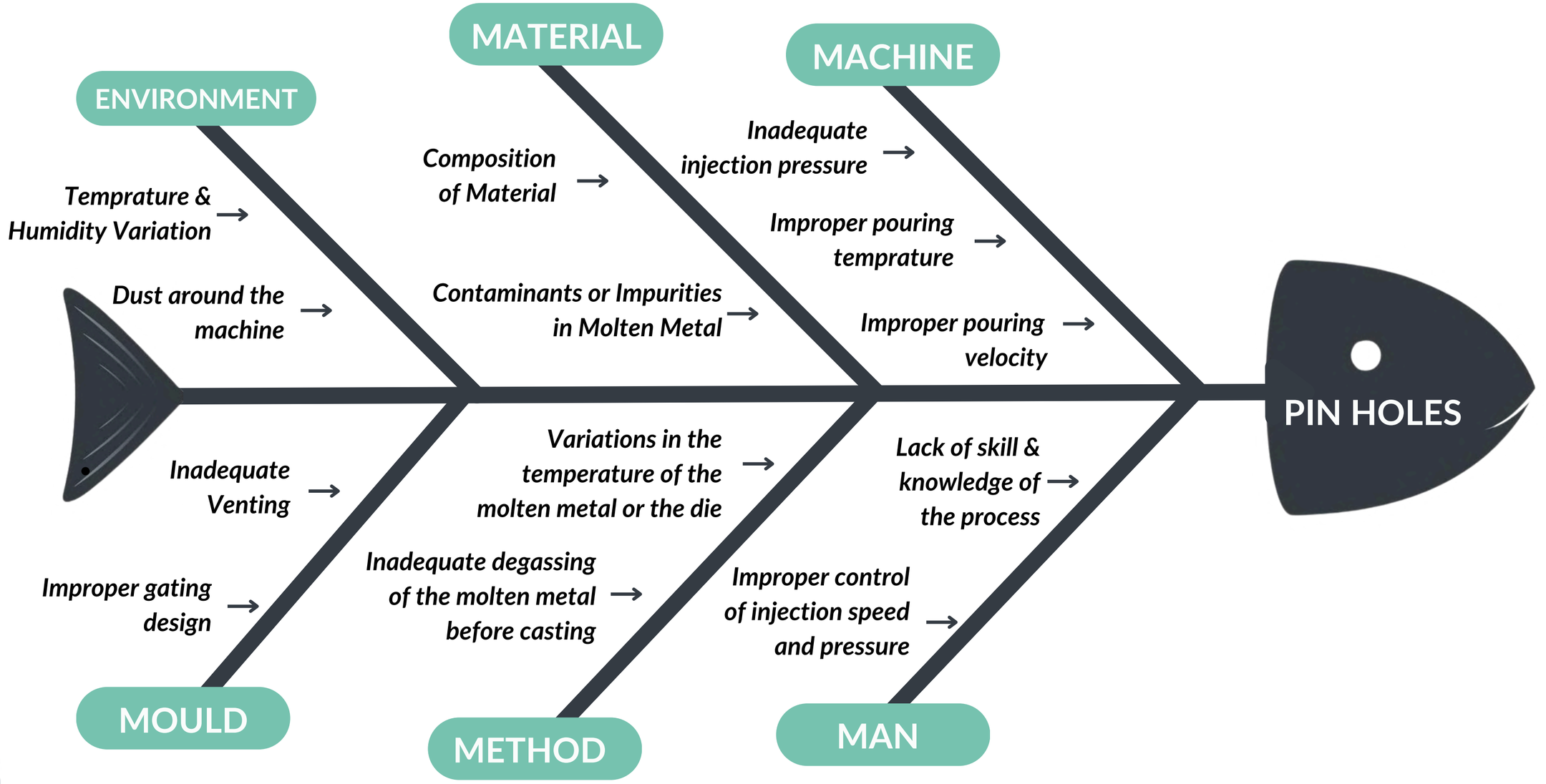
ROOT CAUSE :

- *Improper gating system*
- *Inadequate injection pressure*
- *Temprature & humidity variation*

CORRECTIVE MEASURES :

- *Redesign the gating system using simulation software for smooth and uniform metal flow, and adjust injection pressure to ensure complete and consistent mold filling without inducing excessive stress.*
- *Adjust dwell time to allow for proper filling of the die cavity without inducing excessive thermal stress.*
- *Implement proper cooling systems in the die to ensure controlled solidification and minimize thermal shock.*
- *Implement effective metal cleaning and degassing procedures to remove impurities and gases from the molten metal.*
- *Enhanced intervention to allow for the escape of trapped gases during the casting process, reducing the likelihood of defects.*

CAUSE & EFFECT DIAGRAM OF PIN HOLES :



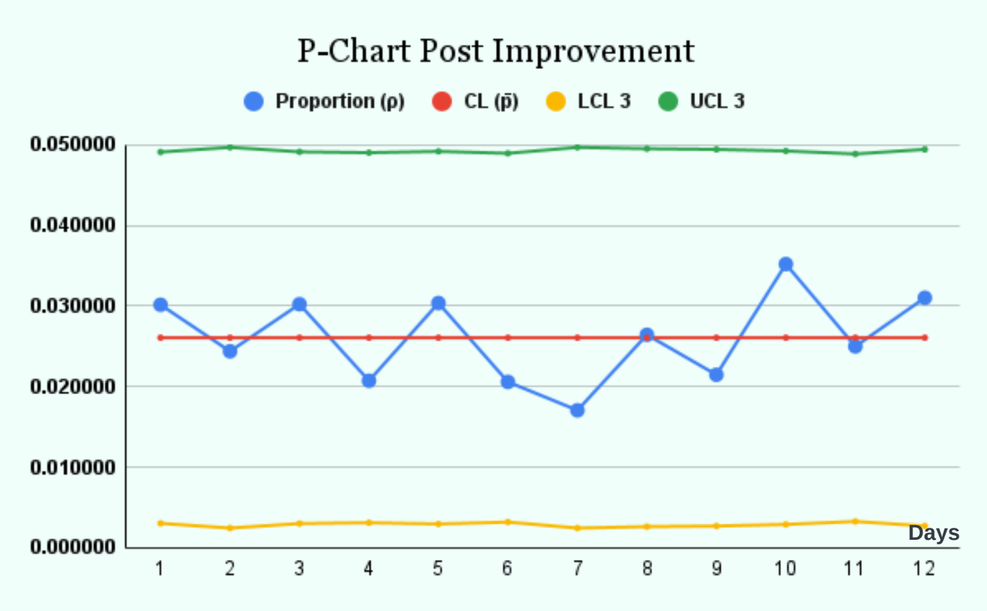
ROOT CAUSE :

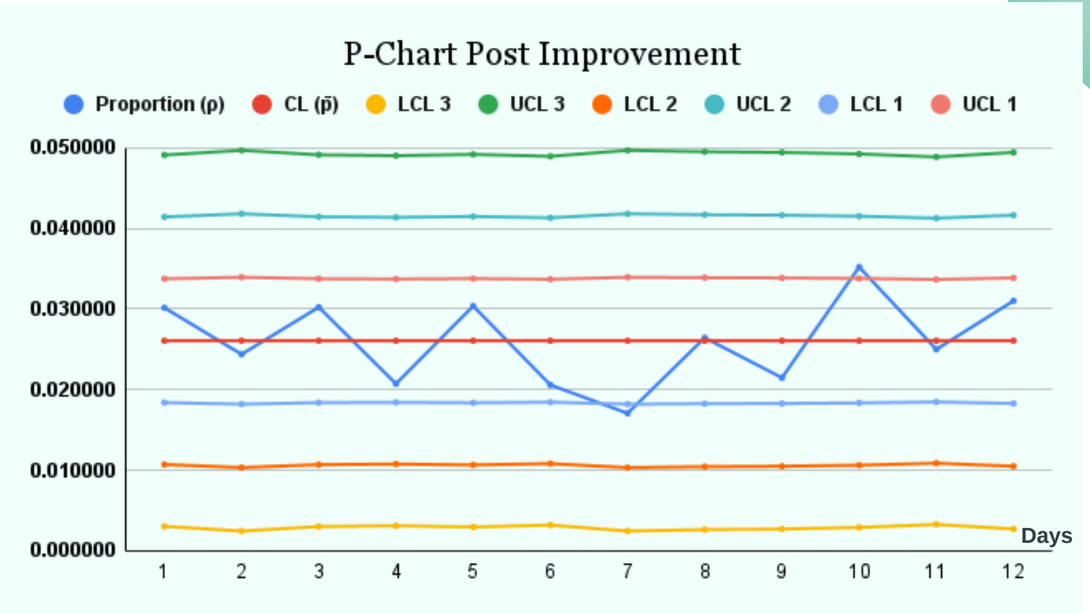
- *Inadequate venting*
- *Improper pouring temprature*

CORRECTIVE MEASURES :

- *Ensure proper vent design and placement to facilitate gas evacuation without compromising casting integrity.*
- *Maintain consistent injection pressure and velocity to promote smooth metal flow and minimize gas entrapment.*
- *Adjust injection parameters based on the size and complexity of the casting to ensure complete cavity filling without inducing excessive turbulence.*
- *Implement proper cooling systems in the die to ensure controlled solidification and minimize the formation of shrinkage voids.*

IMPROVEMENT & CONTROL :





Defectives	133
Opportunities	5
Total Units	5100
Total Opportunities	25500

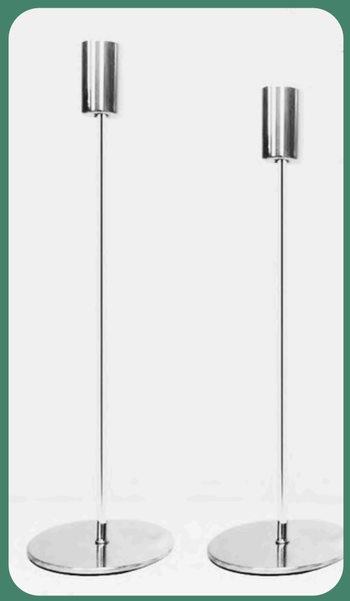
DPU	0.02607843137
DPO	0.00521568627
DPMO	5215.686275
Yield	99.47843137
Sigma Value	4.061191882

Defects	Non Filling	Pin Holes	Cold Shot	Dent	Crack
Pre Analysis	3.36	17.36	3.88	2.8	19.88
Post Analysis	1.583	6.333	2.25	2.5	5.16

STAGE 2

Stage 2 comprises surface preparation, grinding, Intermediate Polishing, Final Polishing, and Cleaning.

The polishing process is a critical step in the manufacturing of aluminium candle stands, enhancing both the aesthetic appeal and surface quality of the product. This process involves several stages to ensure a smooth, shiny, and defect-free finish on the aluminum surface. The aluminum candle stands are thoroughly inspected for any surface defects or irregularities that need to be addressed before polishing.



SIPOC DIAGRAM:

SUPPLIER

- *Abrasive Material Suppliers*
- *Polishing Compound Suppliers*
- *Equipment Suppliers (e.g., polishing machines, grinding wheels)*
- *Cleaning Agents Suppliers*

INPUTS

- *Candle Stands (from previous stage)*
- *Abrasive Materials*
- *Polishing Compounds (fine abrasives)*
- *Polishing Equipment*
- *Cleaning Agents*
- *Inspection Tools*

PROCESS

- *Surface Preparation*
- *Grinding*
- *Intermediate Polishing*
- *Final Polishing*
- *Cleaning*

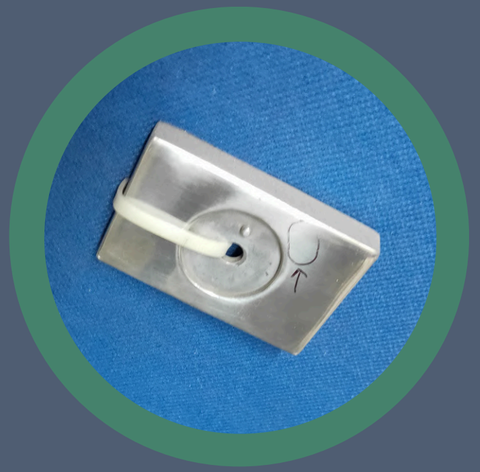
OUTPUT

- *Polished Aluminum Candle Stand*
-

CUSTOMER

- *Next process: Electrophoretic lacquering*

DEFECTS:



TOOL MARKS

SCRATCH MARKS

BUFF MARKS

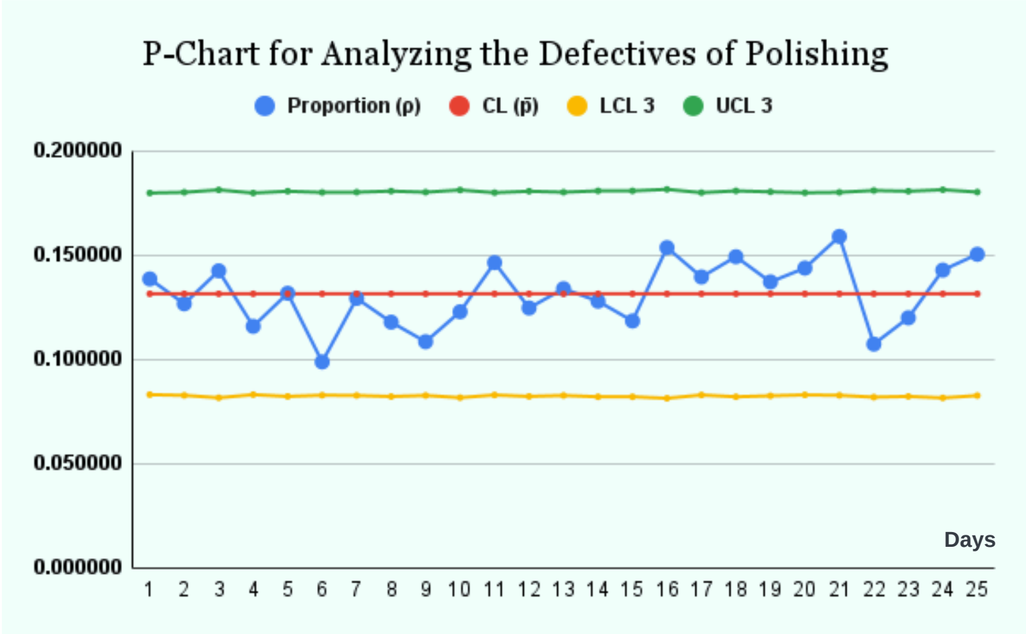
LANCER MARKS

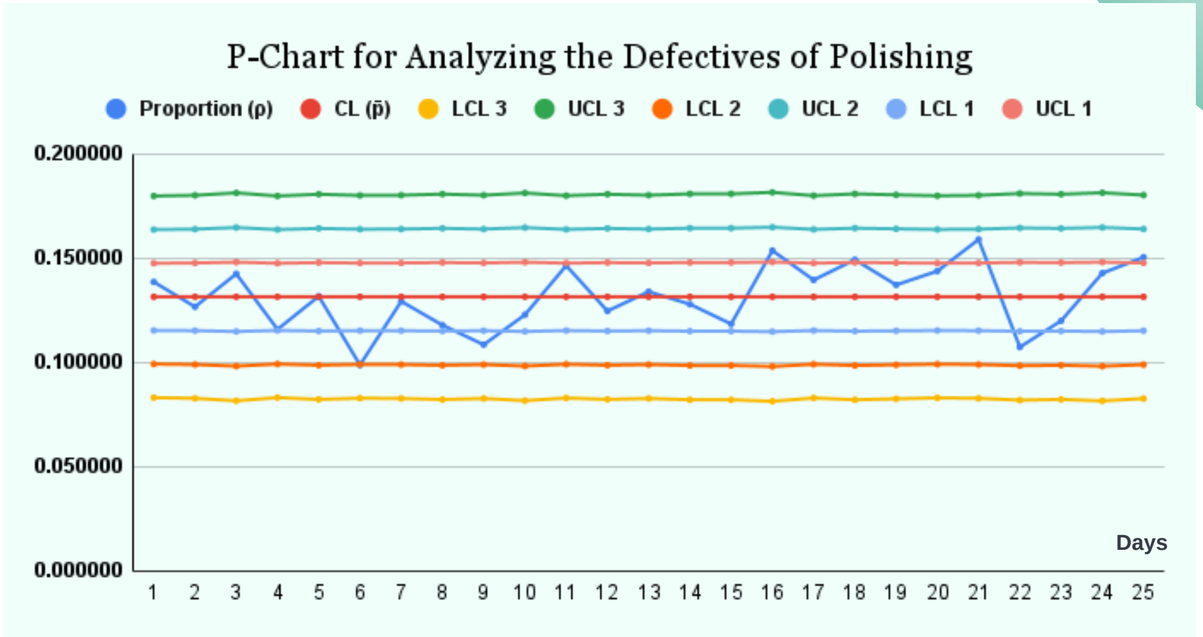
BLACKNESS

IMPROPER POLISHING

IMPROPER TEXTURE

MEASURE:

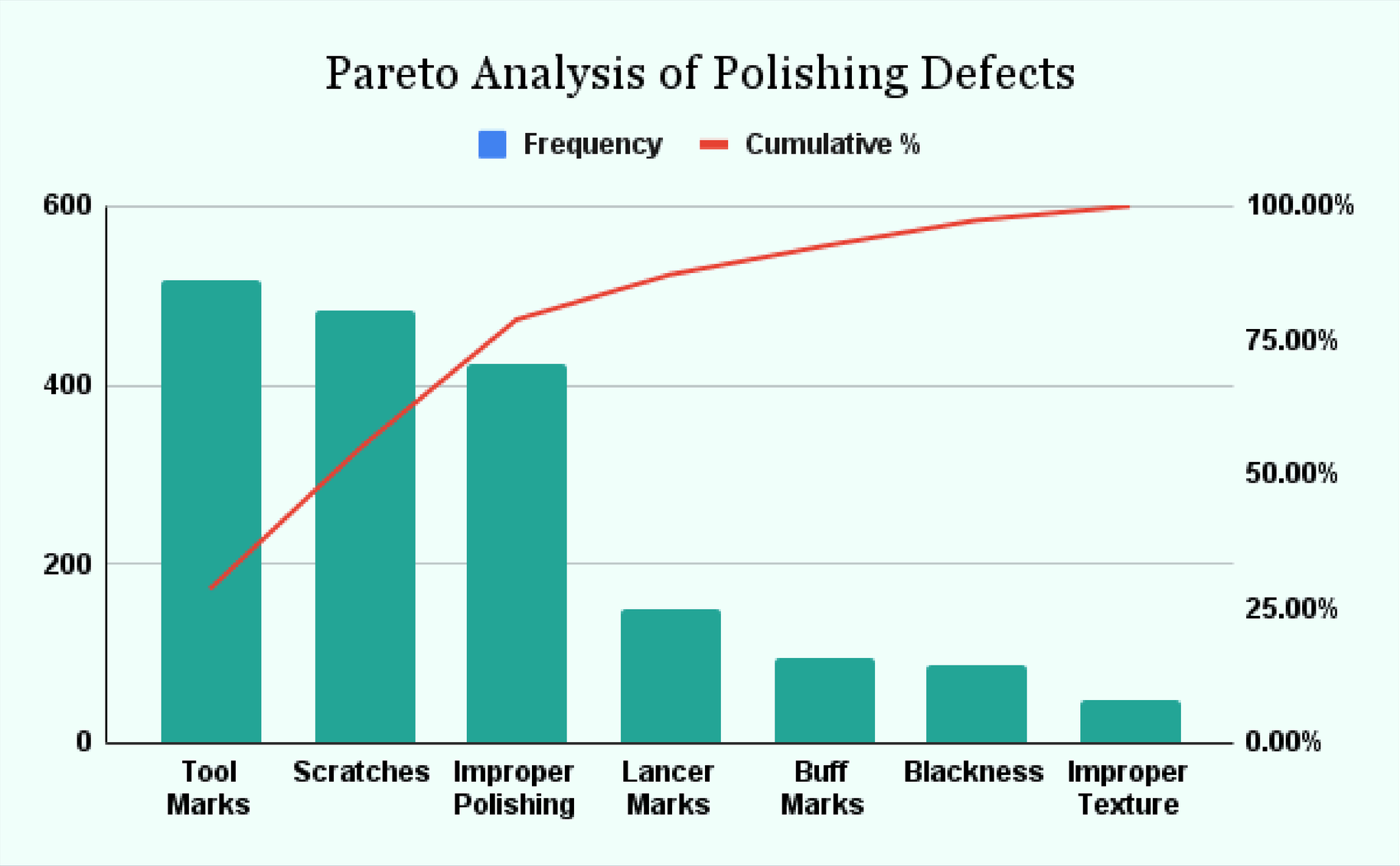




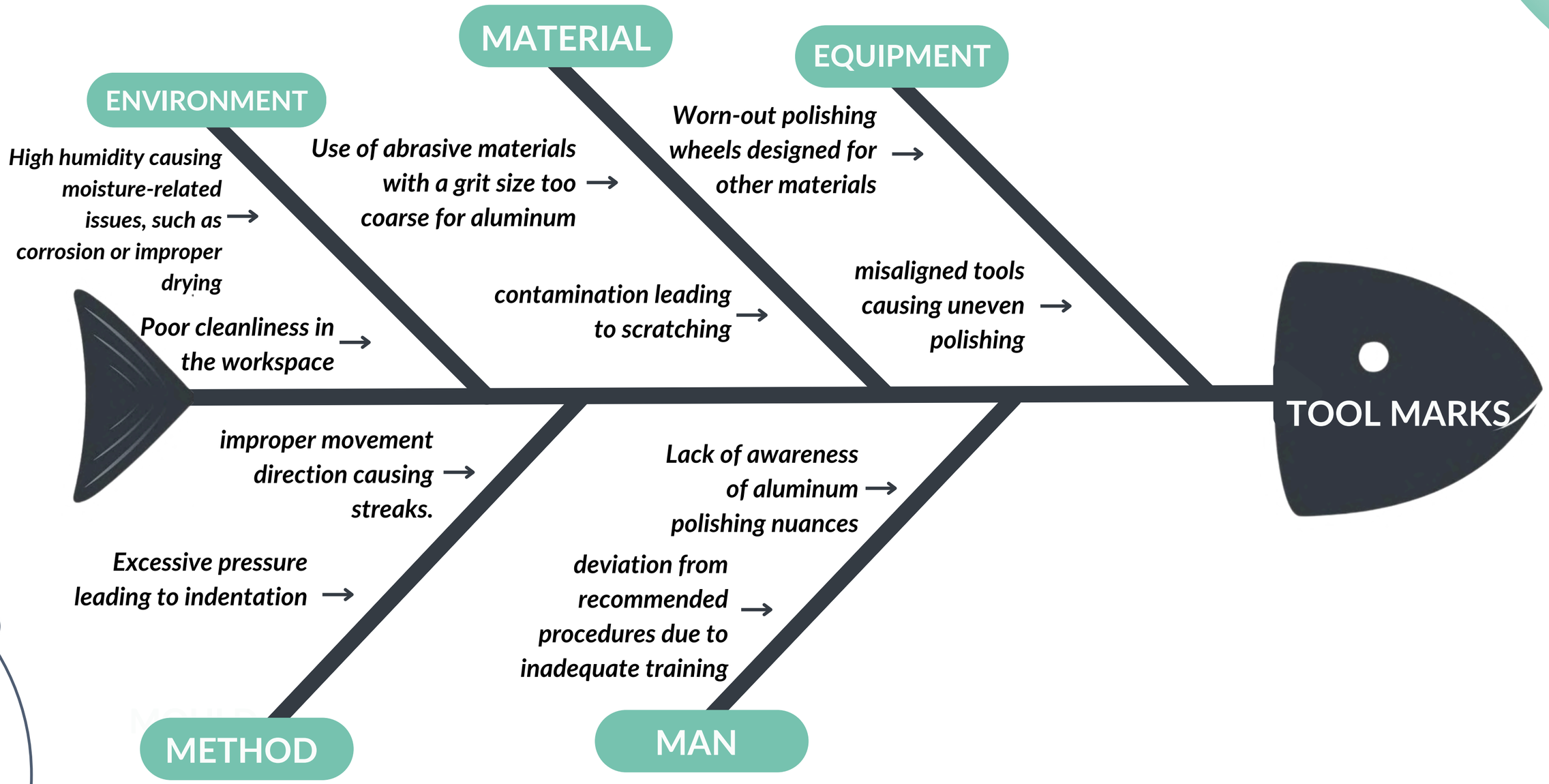
Defectives	1406
Opportunities	7
Total Units	10692
Total Opportunities	74844

DPU	0.1315001871
DPO	0.01878574101
DPMO	18785.74101
Yield	98.1214259
Sigma Value	3.579499299

ANALYSE :


Pareto Analysis of Polishing Defects
Frequency
Cumulative %
600
400
200
0
100.00%
75.00%
50.00%
25.00%
0.00%
Tool Marks
Scratches
Improper Polishing
Lancer Marks
Buff Marks
Blackness
Improper Texture

CAUSE & EFFECT DIAGRAM OF TOOL MARKS :



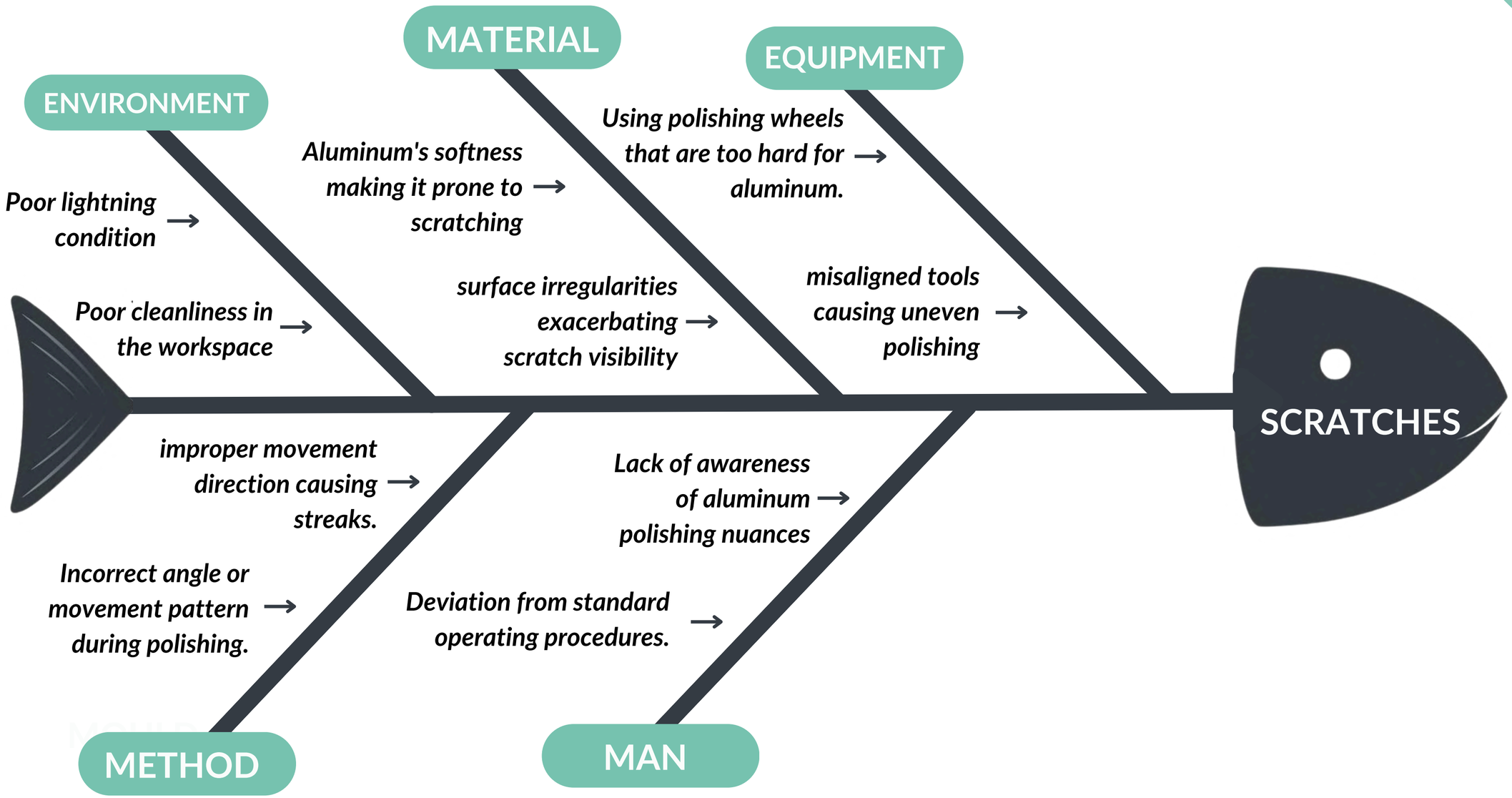
ROOT CAUSE :

- *Worn-out polishing tools causing uneven surface contact.*
- *Excessive pressure applied during the polishing process.*
- *Contaminated abrasive materials scratching the aluminium surface.*

CORRECTIVE MEASURES :

- *Implement a regular maintenance and replacement schedule for polishing tools to ensure they are in good condition.*
- *Provide training for operators on proper polishing techniques, emphasizing the importance of applying consistent and appropriate pressure.*
- *Establish strict procedures for storing and handling abrasive materials to keep them clean and free from contaminants.*
- *Conduct regular calibration and alignment checks for polishing equipment to ensure tools are correctly positioned and functioning properly.*

CAUSE & EFFECT DIAGRAM OF SCRATCHES :



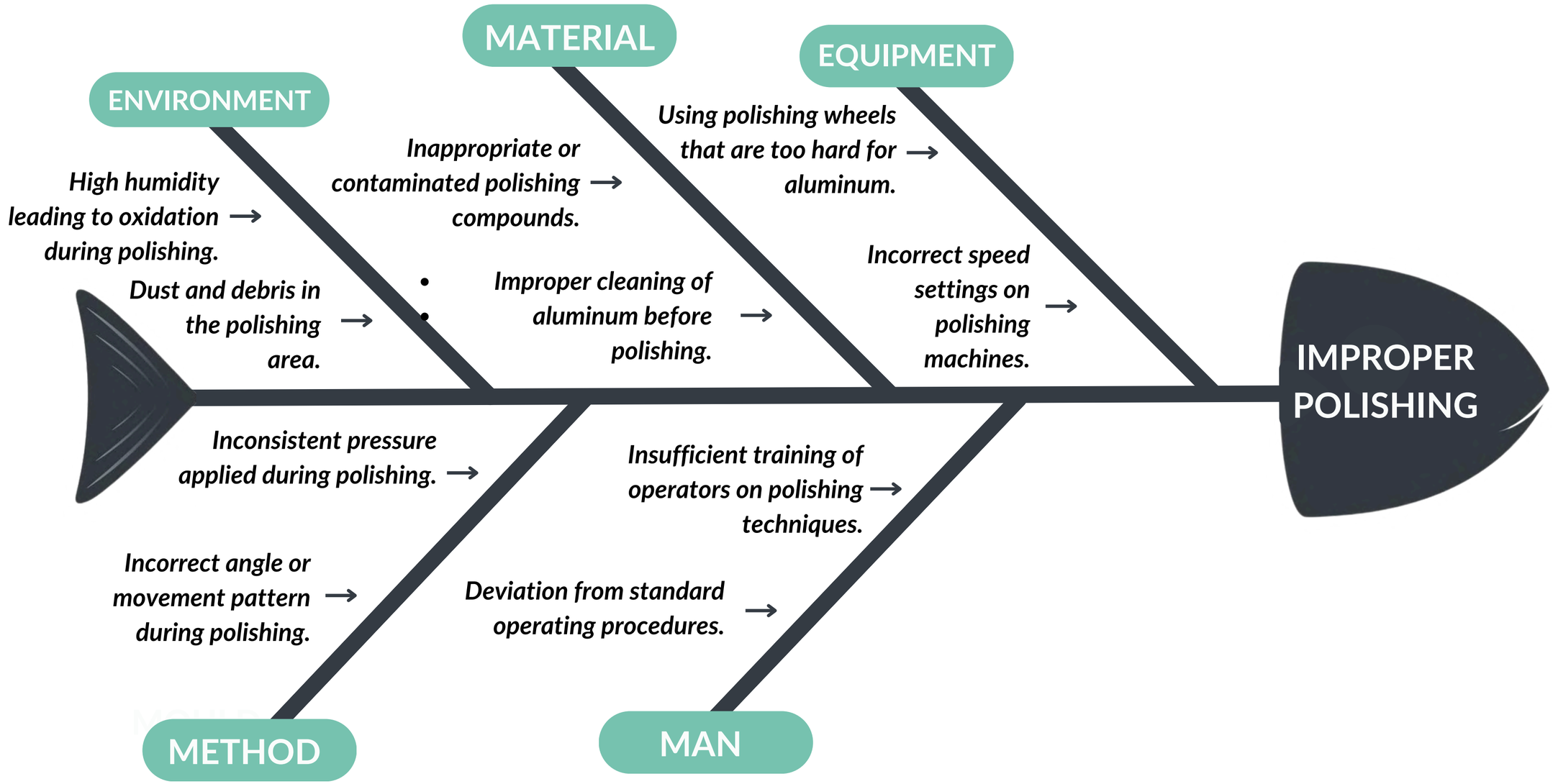
ROOT CAUSE :

- *Use of abrasive materials with incorrect grit size.*
- *Presence of contaminants on the aluminium surface or polishing tools.*
- *Inadequate cleaning between polishing steps*

CORRECTIVE MEASURES :

- *Ensure the selection of appropriate grit sizes for each polishing stage, starting with coarser grits and progressing to finer grits as needed.*
- *Implementstrict cleaning protocols for the aluminium workpieces and polishing tools to remove any dust, dirt, or debris before polishing begins.*
- *Establish thorough cleaning procedures between each polishing step to remove residual abrasive particles and prevent cross-contamination*
- *Store abrasive materials in a clean, dry environment to prevent contamination and ensure they remain in optimal condition for polishing*

CAUSE & EFFECT DIAGRAM OF IMPROPER POLISHING :



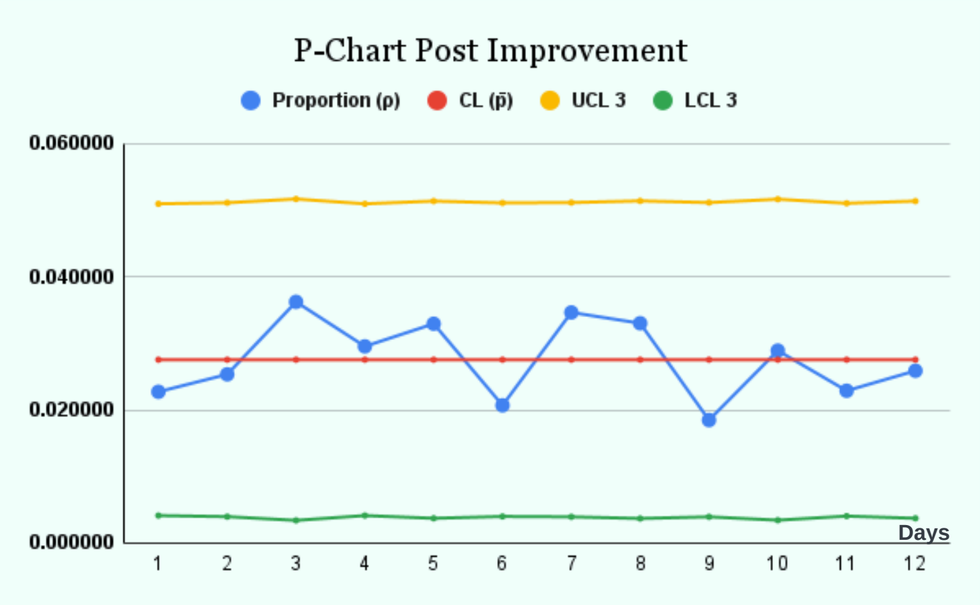
ROOT CAUSE :

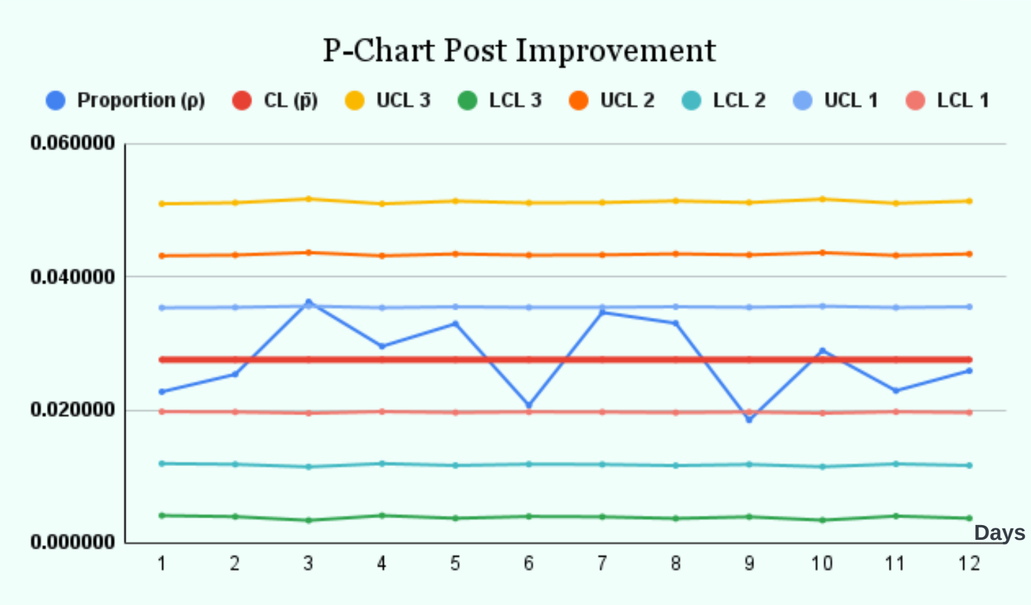
- *Inconsistent pressure application during polishing.*
- *Improper polishing technique results in inconsistent surface texture.*
- *Use of inappropriate polishing compounds or abrasives*

CORRECTIVE MEASURES :

- *Provide training to operators on maintaining consistent pressure during polishing to ensure uniformity in the surface finish.*
- *Evaluate and select polishing compounds specifically designed for aluminium surfaces to ensure effective polishing without causing damage.*
- *Regularly inspect and maintain polishing equipment to ensure optimal performance and consistency in the polishing process.*
- *Implement stringent quality control checks throughout the polishing process to detect and rectify any inconsistencies in the surface finish promptly*

IMPROVEMENT & CONTROL :





Defectives	142
Opportunities	7
Total Units	5155
Total Opportuni	36085

DPU	0.02754607177
DPO	0.003935153111
DPMO	3935.153111
Yield	99.60648469
Sigma Value	4.157583627

Defects	Tool Marks	Scratches	Buff Marks	Lancer Mark	Blackness	Improper Polishing	Improper Texture
Pre Analysis	20.75	19.32	3.84	6.04	3.48	16.92	1.92
Post Analysis	6	7.58	1.58	2.5	1.16	9.16	0.66

STAGE 3

Stage 3 comprises Cleaning, Electrophoretic lacquering, Coating, and Baking.
Electrophoretic lacquering, also known as e-coating, is a process used to apply a protective and decorative coating to metal surfaces. This process involves the deposition of paint particles onto a substrate using an electrical current. In the electrophoretic lacquering process, aluminium candle stands are submerged in a bath containing a water-based paint or lacquer solution. An electrical current is applied, causing the paint particles to migrate towards and uniformly coat the aluminium surfaces. This process ensures an even, durable, and corrosion-resistant finish. After coating, the items are rinsed and cured in an oven to achieve the final hardened finish

PRE RINSE

EPL GOLD

POST RINSE

SIPOC DIAGRAM:

SUPPLIER

- *Paint and lacquer suppliers*
- *Equipment suppliers (e-coating tanks, power supplies, curing ovens)*
- *Chemical suppliers (for bath solution components)*
- *Water supply*

INPUTS

- *Aluminium candle stands (polished and cleaned)*
- *E-coating bath solution*
- *Electrical power*
- *Rinsing water*
- *Heat energy (for curing)*

PROCESS

- *Preparation*
- *Immersion*
- *Electrodeposition*
- *Rinsing*
- *Curing*

OUTPUT

- *Evenly coated aluminum candle stands*

CUSTOMER

- *End customers purchasing the aluminium candle stand*

DEFECTS:

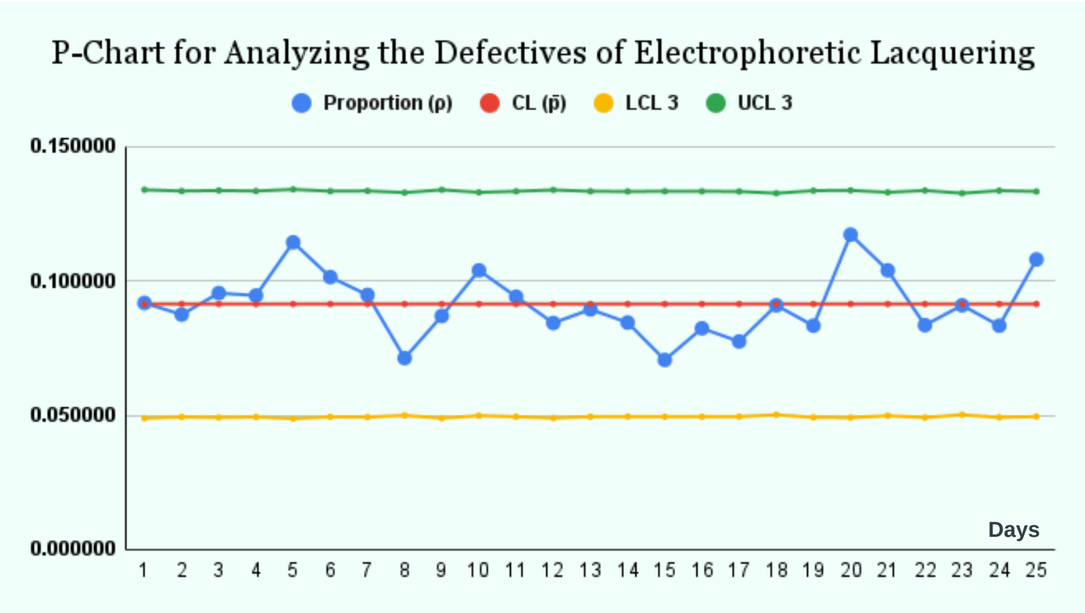
CRATERING

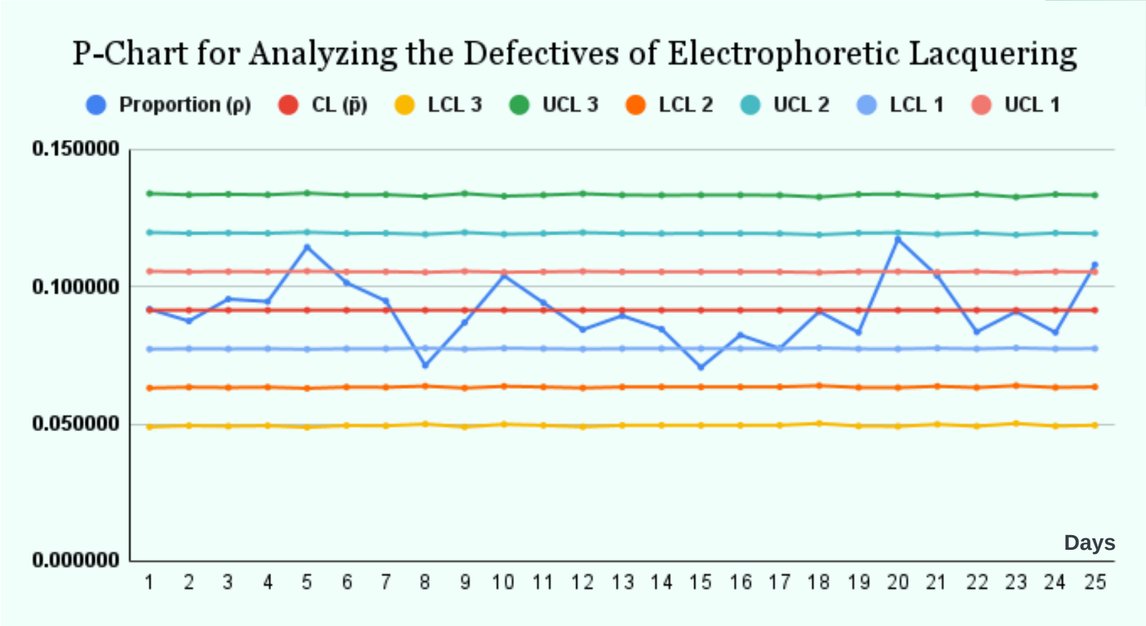
ROUGHNESS

GLOSS / COLOUR VARIATION

RUPTURING

MEASURE:





Defectives	985
Opportunities	4
Total Units	10601
Total Opportunities	42404

DPU	0.09291576266
DPO	0.02322894067
DPMO	23228.94067
Yield	97.67710593
Sigma Value	3.491209306

ANALYSING USING AHP :

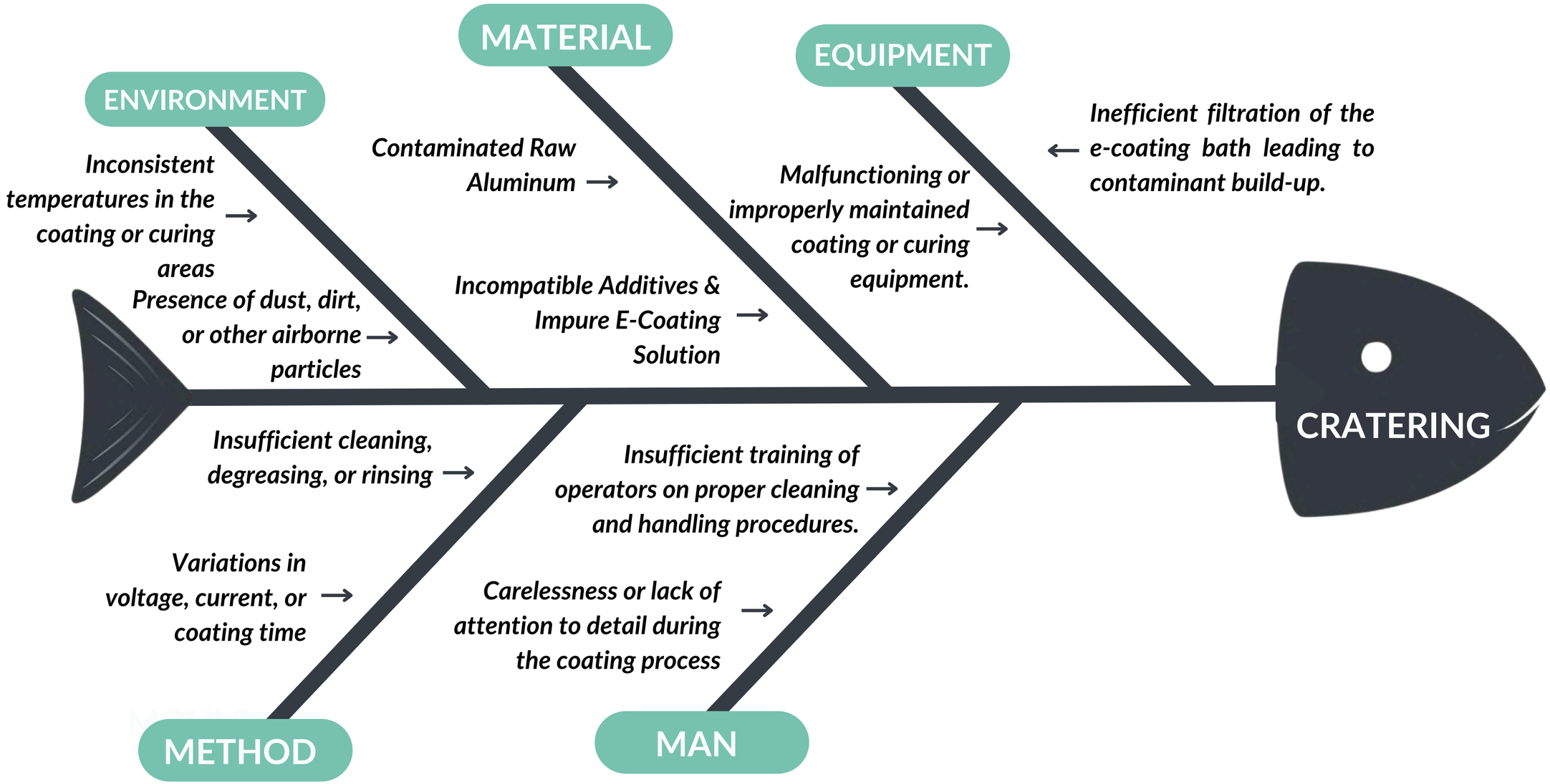
Priority Vector:

Final Priority	criticality to customer	Time requirement	Scope of Improvement	No. of Defectives	Rating
Rupturing	0.052	0.028	0.004	0.033	0.117
Roughness	0.052	0.028	0.004	0.009	0.092
Cratering	0.271	0.080	0.018	0.078	0.446
Gloss/Colour Variation	0.148	0.145	0.037	0.013	0.344

Ranking:

	Rating	Rank
Cratering	0.446	1
Gloss/Colour Variation	0.344	2
Rupturing	0.117	3
Roughness	0.092	4

CAUSE & EFFECT DIAGRAM OF CRATERING :



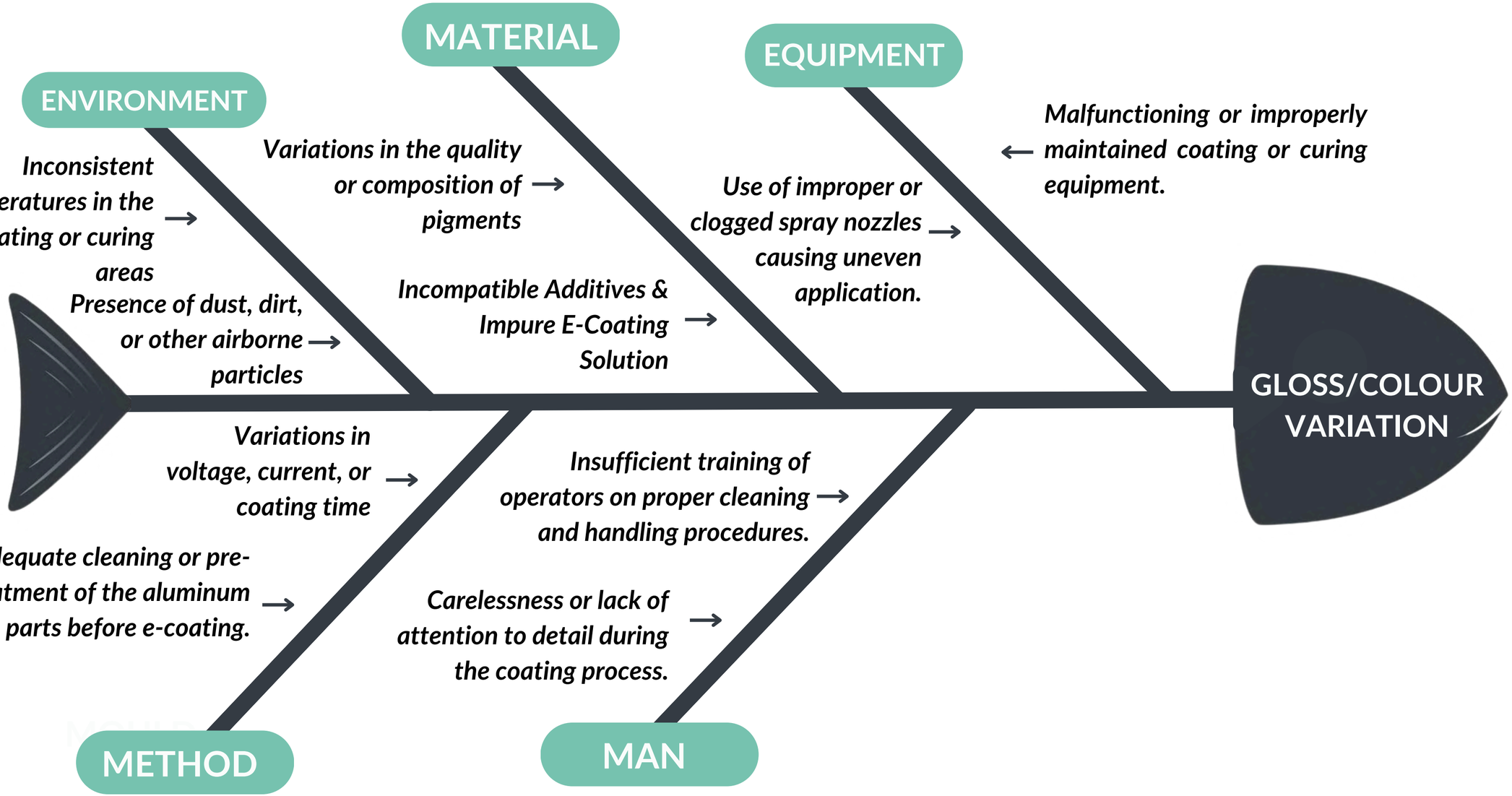
ROOT CAUSE :

- *Contaminants in the e-coating bath.*
- *Inadequate surface preparation of the aluminium parts.*
- *Improper curing temperatures or times*

CORRECTIVE MEASURES :

- *Implement strict filtration and cleaning protocols for the e-coating bath to remove contaminants*
- *Enhances surface preparation procedures to ensure thorough cleaning and degreasing of aluminium parts before coating.*
- *Maintain accurate and consistent curing temperatures and times by regularly calibrating curing ovens.*
- *Conduct regular quality checks and maintenance of the e-coating bath to ensure chemical balance and purity.*
- *Improve operator training to ensure adherence to proper surface preparation and coating procedures*

CAUSE & EFFECT DIAGRAM OF GLOSS / COLOUR VARIATION :



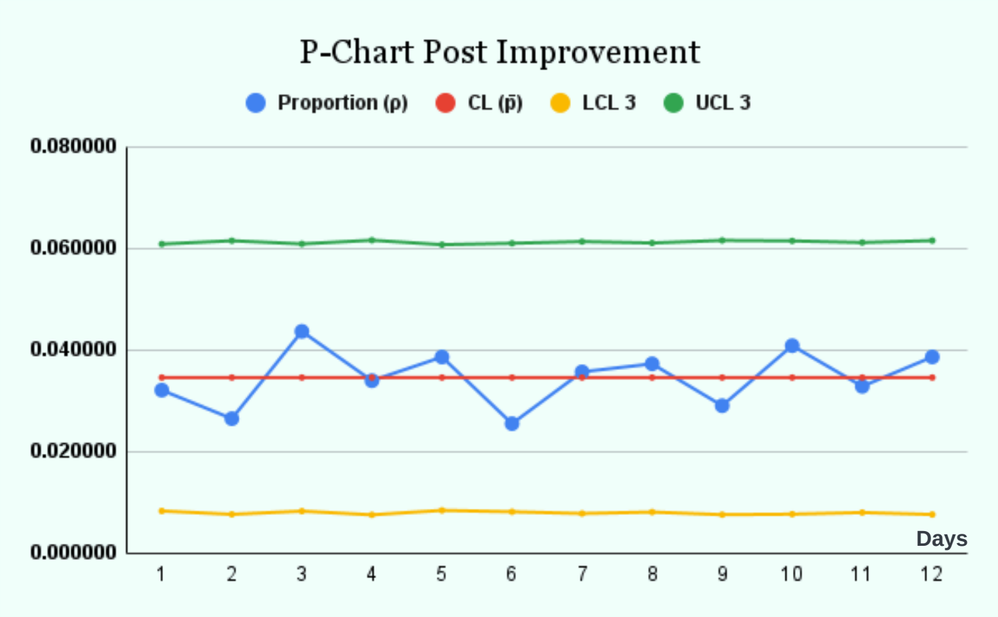
ROOT CAUSE :

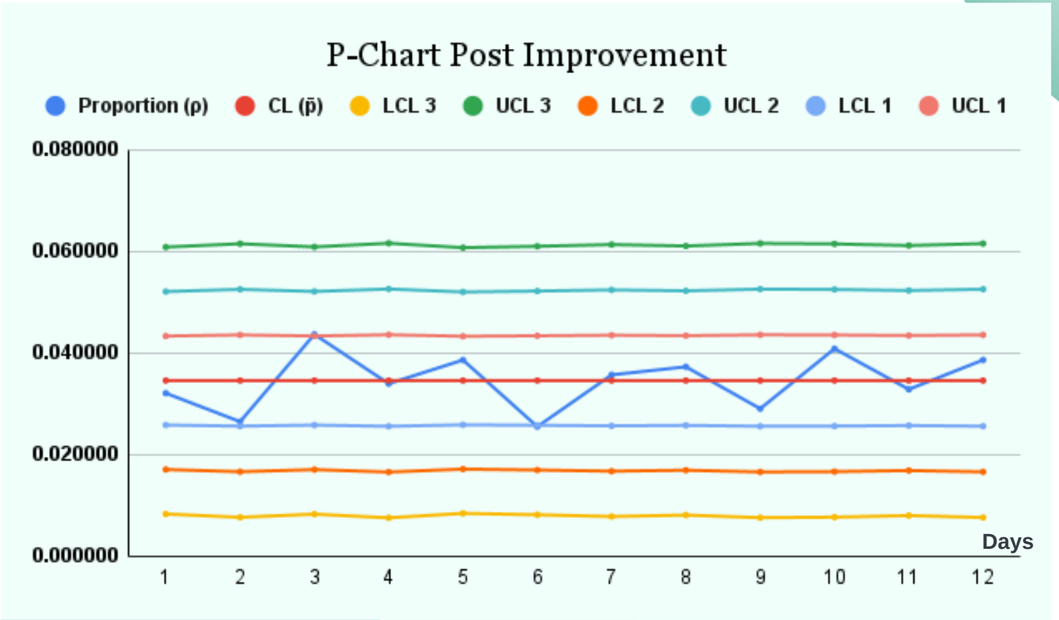
- *Inconsistent application parameters such as voltage and current during the e-coating process.*
- *Improper mixing or agitation of the e-coating solution leading to uneven pigment distribution.*
- *Temperature fluctuations in the curing oven.*

CORRECTIVE MEASURES :

- *Ensure consistent voltage, current, and coating time during the e-coating process by regularly calibrating equipment and following established protocols.*
- *Implement thorough mixing and agitation practices for the e-coating solution to achieve uniform pigment dispersion and maintain solution homogeneity.*
- *Maintain stable and consistent temperatures in the curing oven by using calibrated temperature controls and monitoring systems to prevent fluctuations.*
- *Conduct regular inspections and tests of the e-coating solution, raw materials, and final products to ensure consistent colour and gloss levels, identifying and addressing any variations promptly*

IMPROVEMENT & CONTROL :





Defectives	176
Opportunities	4
Total Units	5087
Total Opportunities	20348

DPU	0.03459799489
DPO	0.008649498722
DPMO	8649.498722
Yield	99.13505013
Sigma Value	3.880290439

Defects	Cratering	Glass / Colour Variation	Roughness	Rupturing
Pre Analysis	15.96	14.68	11.12	7
Post Analysis	6.91	7.75	4.75	1.67

CONCLUSION

A detailed analysis was done with the help of quality control tools such as check sheets, control charts and cause and effect diagrams. The findings are summarized below in the table:

Process	σ level Pre Analysis	σ level Post Analysis
Stage 1	3.6019	4.0611
Stage 2	3.5794	4.1575
Stage 3	3.5839	3.8805
Overall	**3.5884**	**4.0330**

Hence, the overall Sigma level of the firm for the manufacturing of Aluminium Candle Stand is improved from 3.5884 to 4.0330.

REFERENCES

a) Total Quality Management-2nd Edition Poornima M. Charantimath Publisher PEARSON

b) Statistical quality control by DOUGLAS C. MONTGOMERY

c) Research Paper by: Anshu Gupta, Pallavi Sharma, S. C. Malik, Neha Agarwal and P. C. Jha :"Productivity Improvement in the Chassis Preparation Stage of the Amplifier Production Process: A DMAIC Six Sigma Methodology" November 2016

d) Research Paper by: Anshu Gupta, Pallavi Sharma, S. C. Malik and P. C. Jha : "A DMAIC Six Sigma approach to quality improvement in the final stage of the amplifier production process"

e) An integrated DEMATEL Six Sigma hybrid framework for manufacturing process improvement Anshu Gupta1 · Pallavi Sharma2 · Akansha Jain3 · Hongbo Xue4 · S. C. Malik2 · P. C. Jha3

f) Online Search Engine www.google.com

g) C. L. Gupta Exports Ltd. : https://clgupta.com/home