STATISTICAL ANALYSIS OF DEFECTS IN 1.5 HEAD TIAGO DIESEL ENGINE

T.Y.B.Sc. STATISTICS

FERGUSSON COLLEGE, PUNE 04.

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Introduction

Quality control is the set of measures and procedures to follow in order to ensure that the quality of the product is maintained and improved against a set of benchmarks and that any errors encountered are either eliminated or reduced.

The focus of quality control is to ensure that the product and the product manufacturing are not only consistent but also in line with customer requirements.

Need for QC

1. Encourages quality consciousness
2. Satisfaction of consumers
3. Reduction in production cost
4. Most effective utilisation of resources

Objectives

1. To study the traditional methods of quality control used in Industries.
2. To study the effectiveness of simple statistical quality control tools in complicated analysis
3. To apply SPC tools to the available data and to quantify potential solutions and to study the advanced techniques used for quality control.
4. To study the applications of 7 Diamond Process and Six Sigma.

Detection of problem

- Around 80% of rejections were for

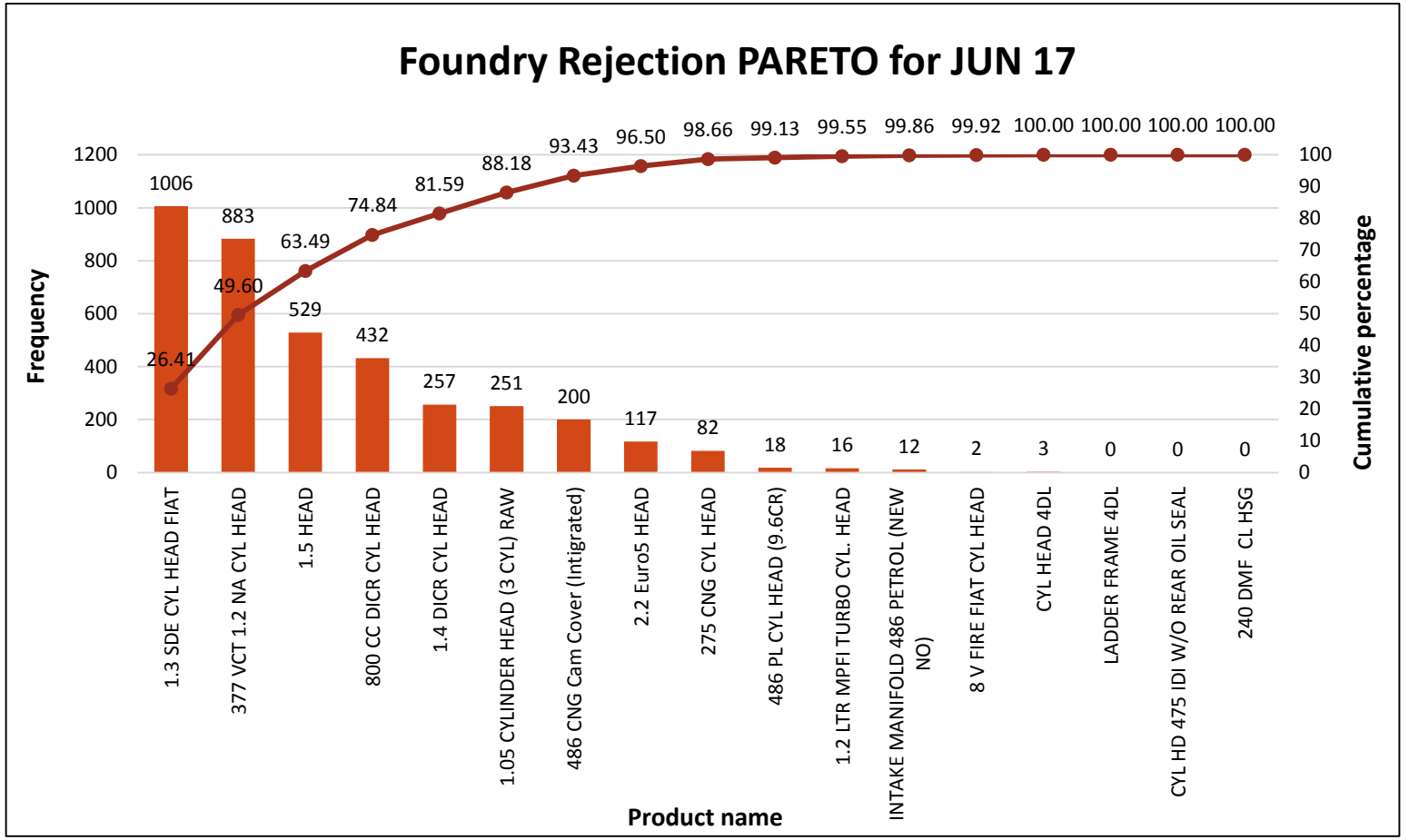
i. 1.3 SDE CYL HEAD FIAT

ii. 377 VCT 1.2 NA CYL HEAD

iii. 1.5 HEAD

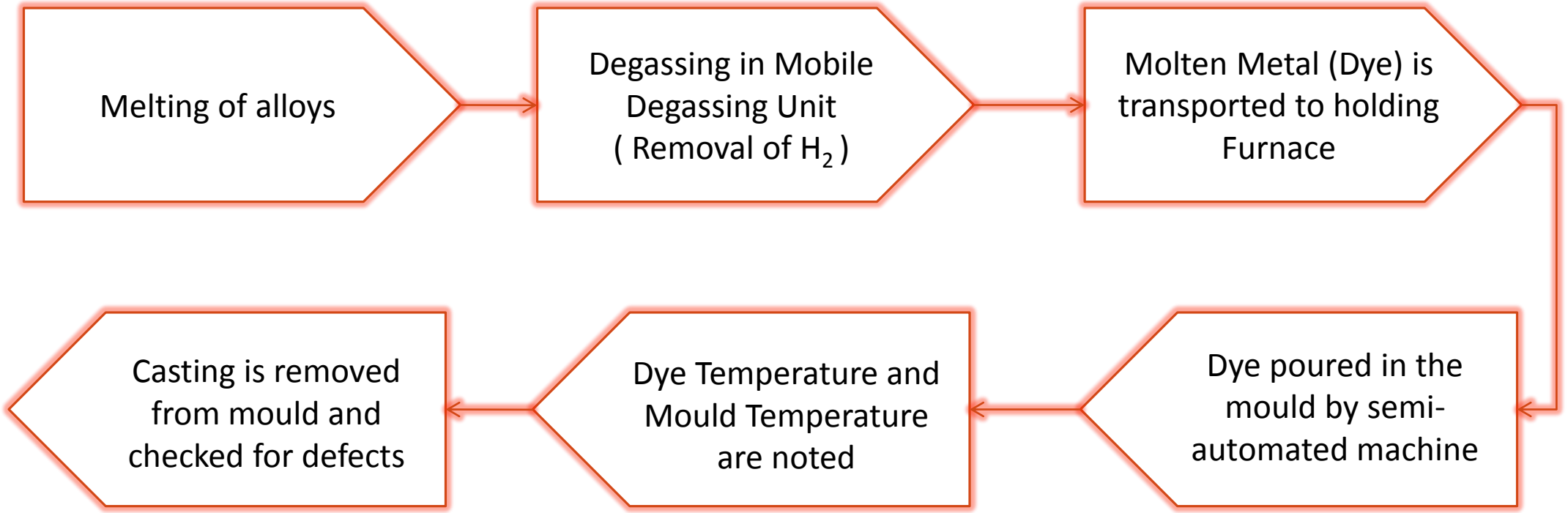
iv. 800 CC DICR CYL HEAD

v. 1.4 DICR CYL HEAD



1.5 Head Tiago Diesel engine

Process


Melting of alloys
Degassing in Mobile Degassing Unit (Removal of H_2)
Molten Metal (Dye) is transported to holding Furnace
Dye poured in the mould by semi-automated machine
Dye Temperature and Mould Temperature are noted
Casting is removed from mould and checked for defects

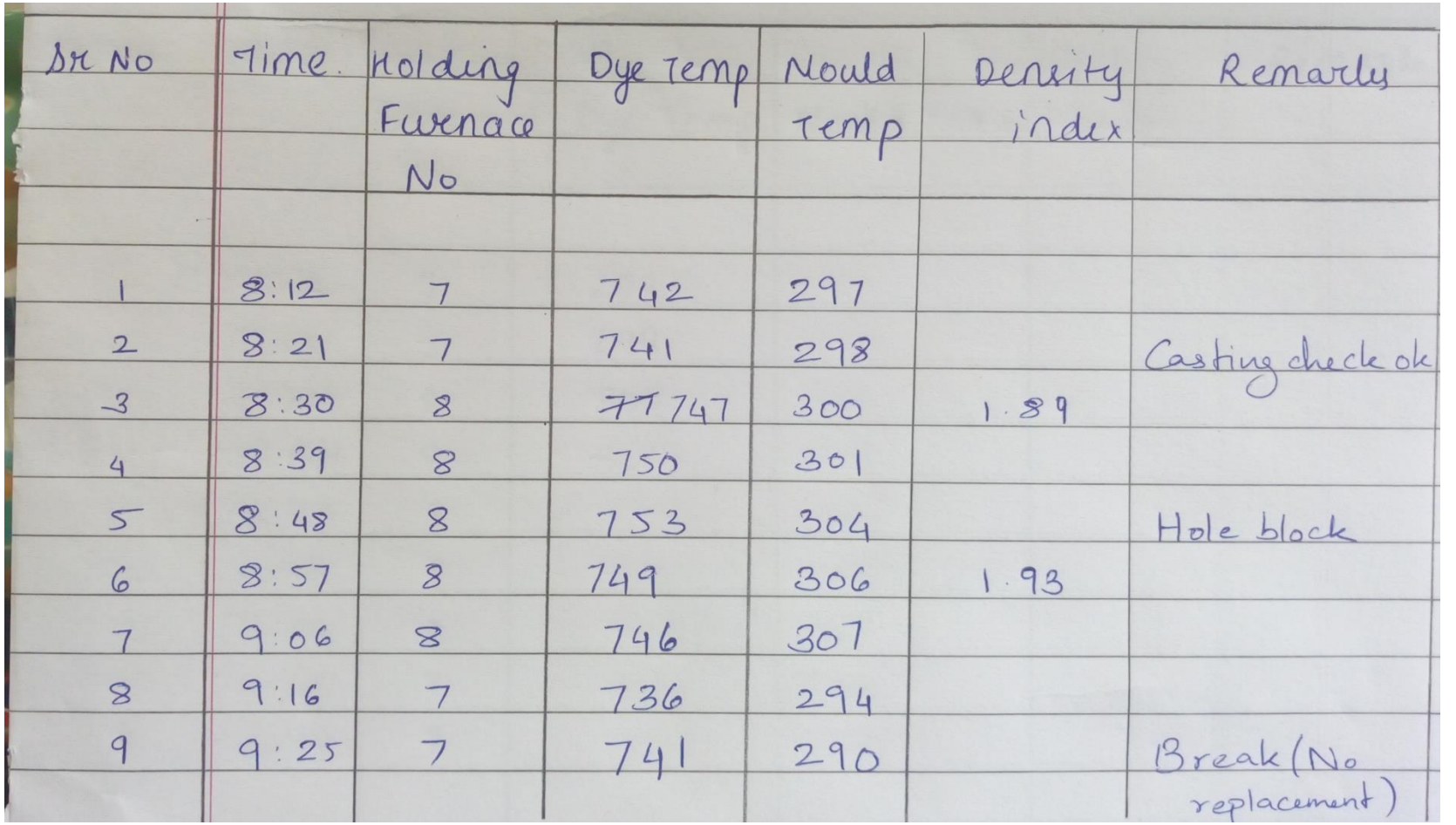
Types of Defects

1. Hole Block(HB)
2. Core Piece Inclusion(CPI)
3. Damage Defect
4. Inhole
5. Cold Metal
6. Untrimmed Core(UTC)
7. Gas Defect

Hole Block

Cold Metal

Our data collection



Sr No	Time	Holding Furnace No	Dye Temp	Nould Temp	Density index	Remarks
1	8:12	7	742	297		
2	8:21	7	741	298		Casting check ok
3	8:30	8	~~77~~ 747	300	1.89	
4	8:39	8	750	301		
5	8:48	8	753	304		Hole block
6	8:57	8	749	306	1.93	
7	9:06	8	746	307		
8	9:16	7	736	294		
9	9:25	7	741	290		Break (No replacement)

Sample data

Fill	Shift	Operator 1	Opeartor 2	Date	Name	Time	Holding furnace no.	Mould Temp	Dye Temp	Density index	Remarks
3	A	Muke	Bhade	27-Aug	1	06:45	7	755	240	1.93	
	A			27-Aug	2	06:54	7	753	242		
	A			27-Aug	3	07:03	7	750	245		
	A			27-Aug	4	07:12	7	748	248		casting check okay
	A			27-Aug	5	07:21	7	745	250		
	A			27-Aug	6	07:30	7	742	252		
	A			27-Aug	7	07:39	7	740	255		
	A			27-Aug	8	07:48	7	742	260		
	A			27-Aug	9	07:57	7	745	265		
	A			27-Aug	10	08:06	7	742	268		
	A			27-Aug	11	08:15	7	740	275		HB
	A			27-Aug	12	08:24	8	762	280	2.04	HB
	A			27-Aug	13	08:33	8	760	282		casting check okay
	A			27-Aug	14	08:42	8	755	283		
	A			27-Aug	15	08:51	8	752	285		
	A			27-Aug	16	09:00	8	750	283		
	A			27-Aug	17	09:09	8	742	284		

Check sheet

- A check sheet is a structured, prepared form for collecting and analysing data.
- This is the sample check sheet used in the Tata Motors, Chinchwad.

FILL LOG BOOK / PROCESS FEEDBACK SHEET

ITEM: 1.5 HEAD OPERATORS: 1) Sutar.V.S DATE: 26/8/17

DIE NO: Fill-3 2) Sane SHIFT: B

DIE TEMP RANGE: **200-350** METAL TEMP RANGE: **735-770**

Sr. No.	Time	Holding Furnace No.	Dye Temp	Mould Temp.	Density index.	Remarks.
106	**09:18**	**08**	**745**	**264**	**1.89**	
107	**09:27**	**08**	**752**	**267**		Casting check OK
108	**09:36**	**08**	**754**	**273**		Hole Block
109	**09:45**	**07**	**753**	**276**		
110	**09:56**	**07**	**749**	**280**	**2.41**	CPI
111	**10:05**	**07**	**739**	**277**		New trolley

Scatter Diagram

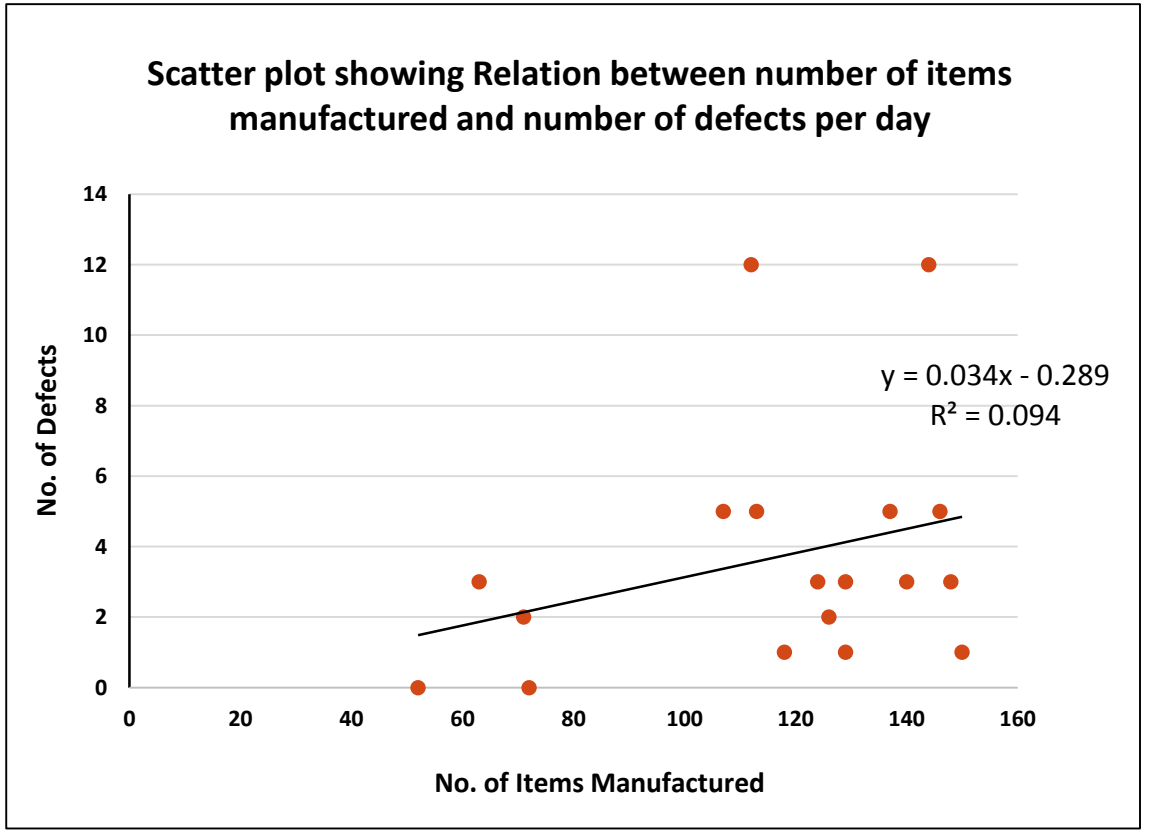
- Scatter diagrams are correlation charts that use regression lines for prediction.

Here,

X: Number of items manufactured per day.

Y: Number of defects observed per day.

Slight positive correlation is observed in X and Y



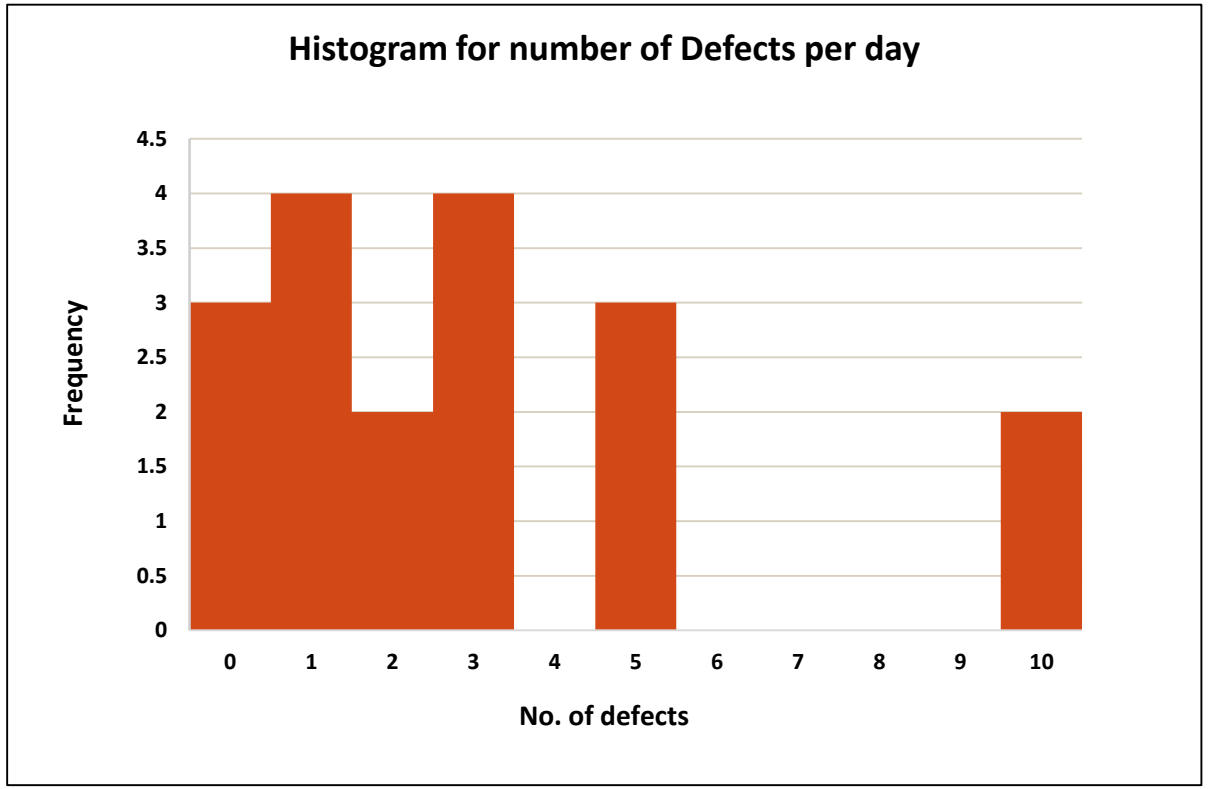
Histogram

- Histogram is used to model frequencies.

Here,

X: Number of defects per day.

The variable X may follow Poisson as the probability of observing a defective item is very less

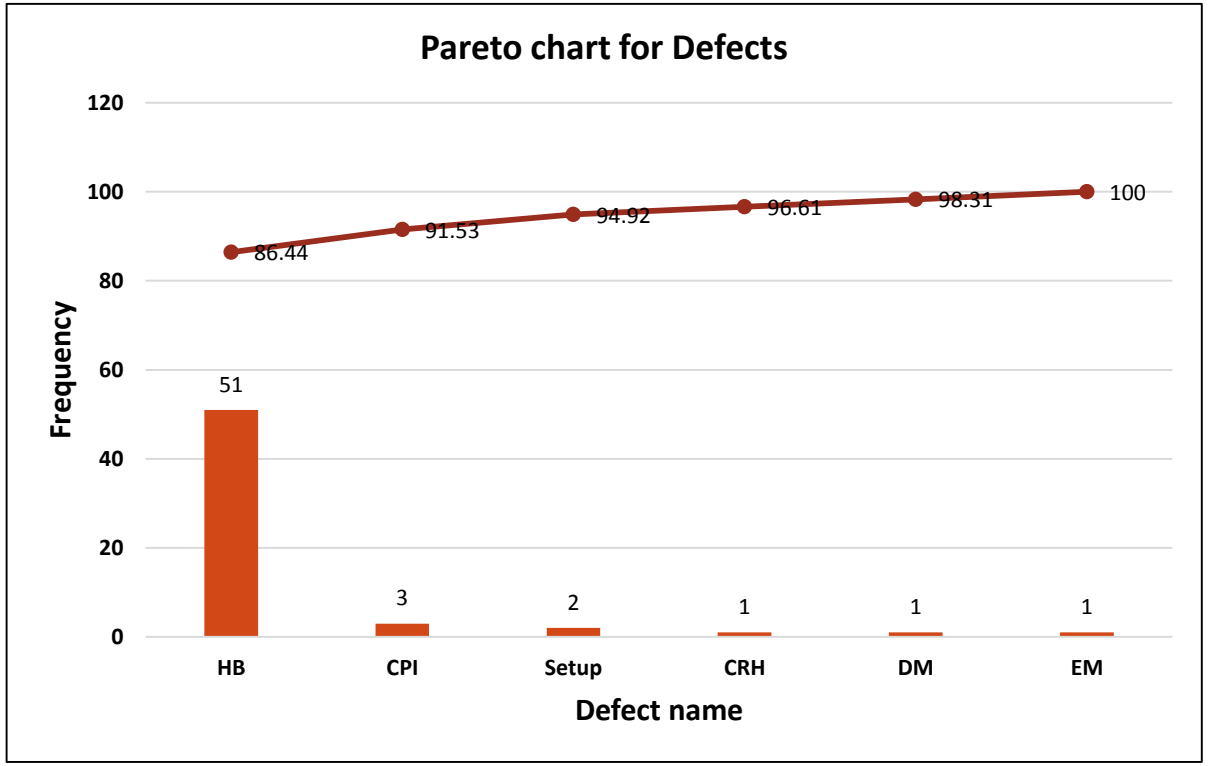


Pareto chart

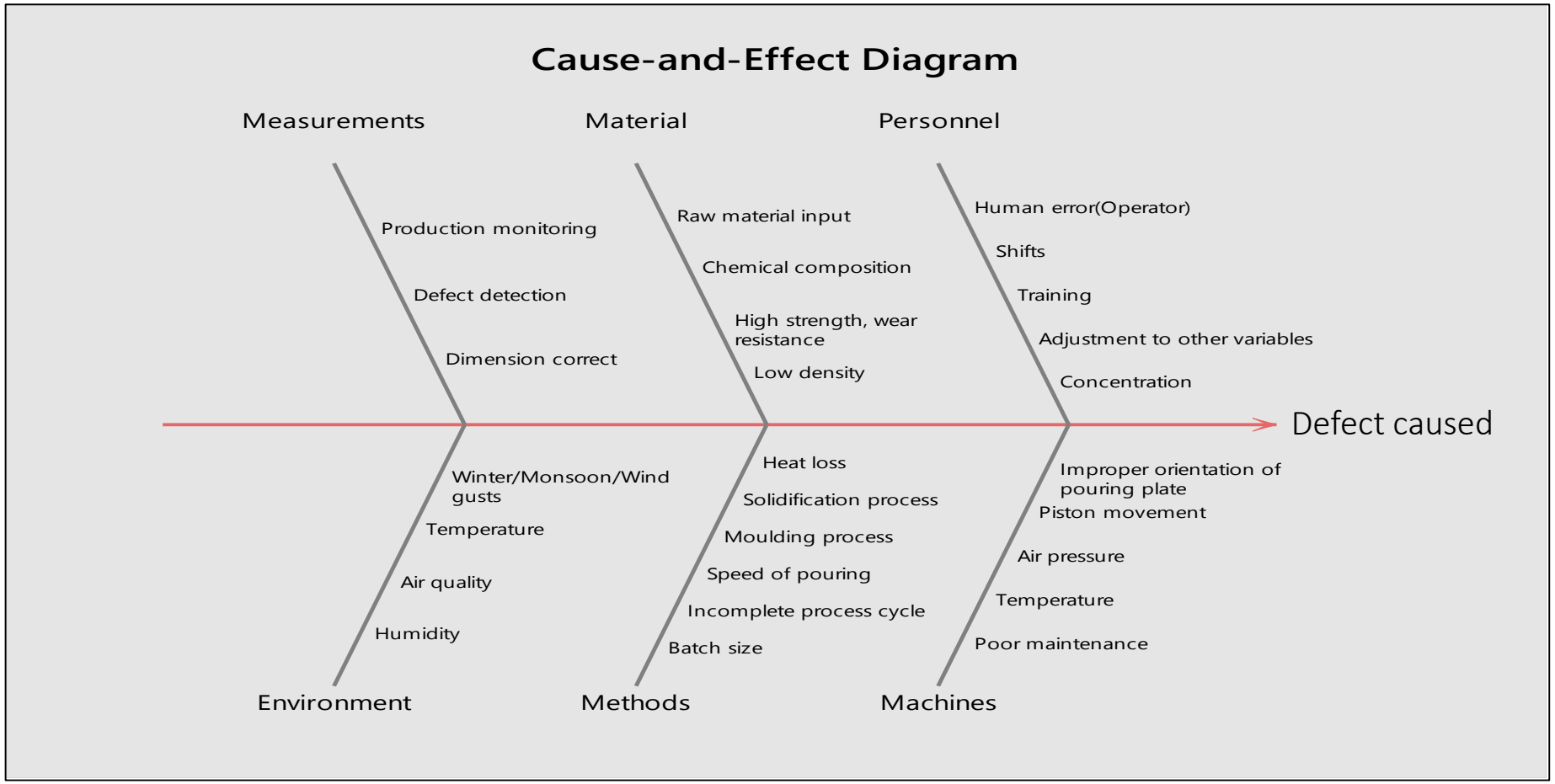
- Based on 80-20 rule of Vilfredo Pareto. This tool separtes “vital few” from “trivial many”.

Here, frequency against the types of defects is plotted.

Hole block is found to be the most occurring defect



Fishbone


Cause-and-Effect Diagram
Measurements
Material
Personnel
Production monitoring
Defect detection
Dimension correct
Raw material input
Chemical composition
High strength, wear resistance
Low density
Human error(Operator)
Shifts
Training
Adjustment to other variables
Concentration
Defect caused
Winter/Monsoon/Wind gusts
Temperature
Air quality
Humidity
Heat loss
Solidification process
Moulding process
Speed of pouring
Incomplete process cycle
Batch size
Improper orientation of pouring plate
Piston movement
Air pressure
Temperature
Poor maintenance
Environment
Methods
Machines

Control charts

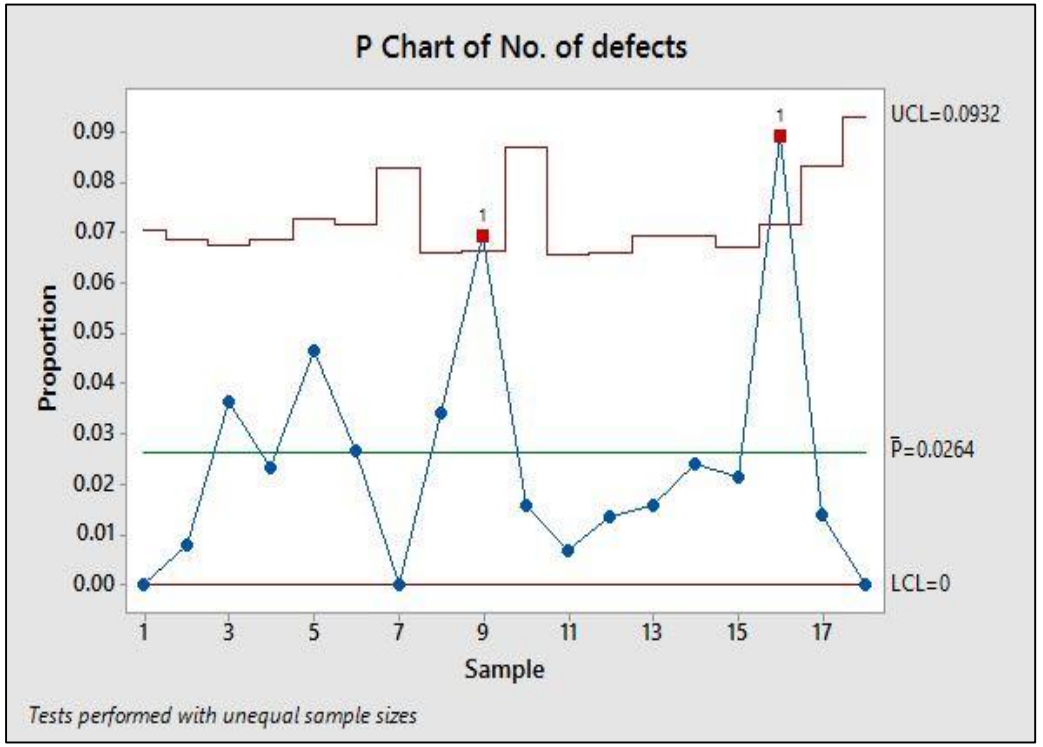
Control charts present a graphic display of process stability or instability over time.

Types of control charts

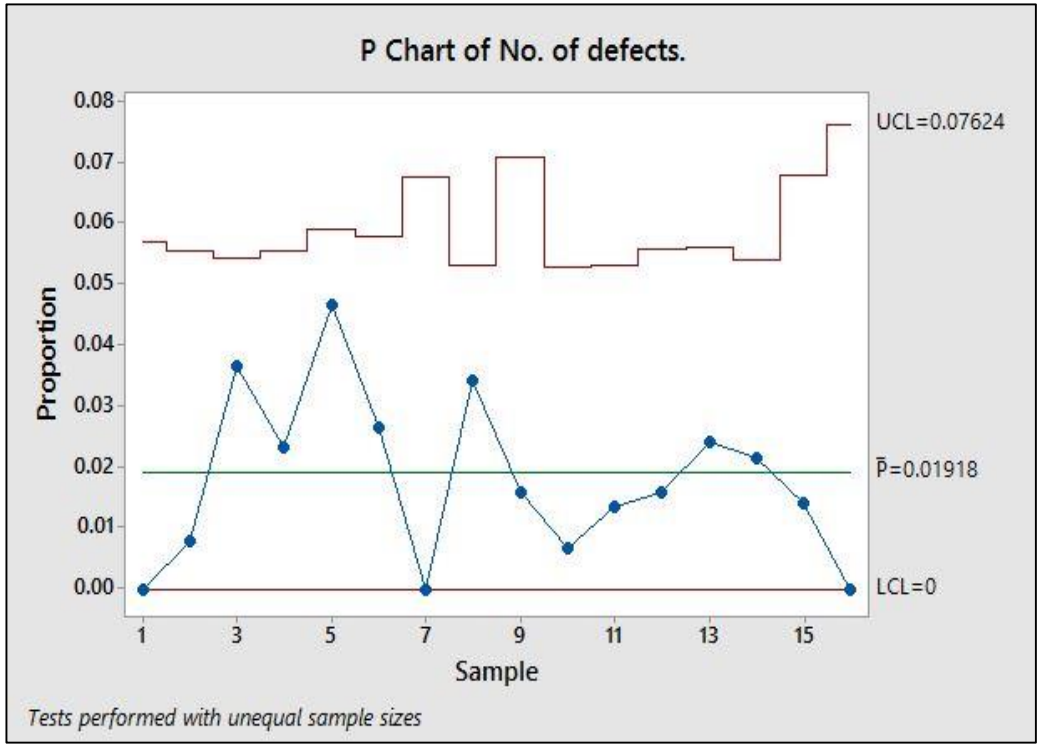
- p chart - Used for percent defectives or for fraction defectives.
- R chart – Used to observe the change in the range of subgroup(spread of data).
- $\overline{X}$ chart – Used to determine whether the process mean is in control.

p Chart (for Attributes)

X_i: Number of non conforming units on i^{th} day.

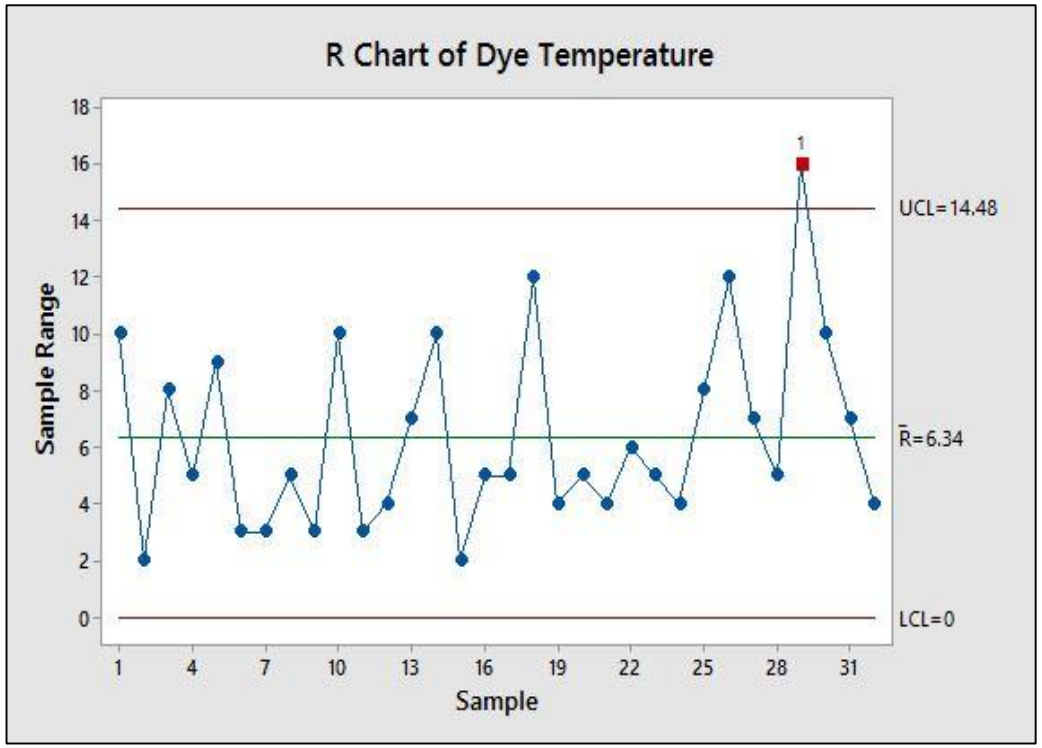


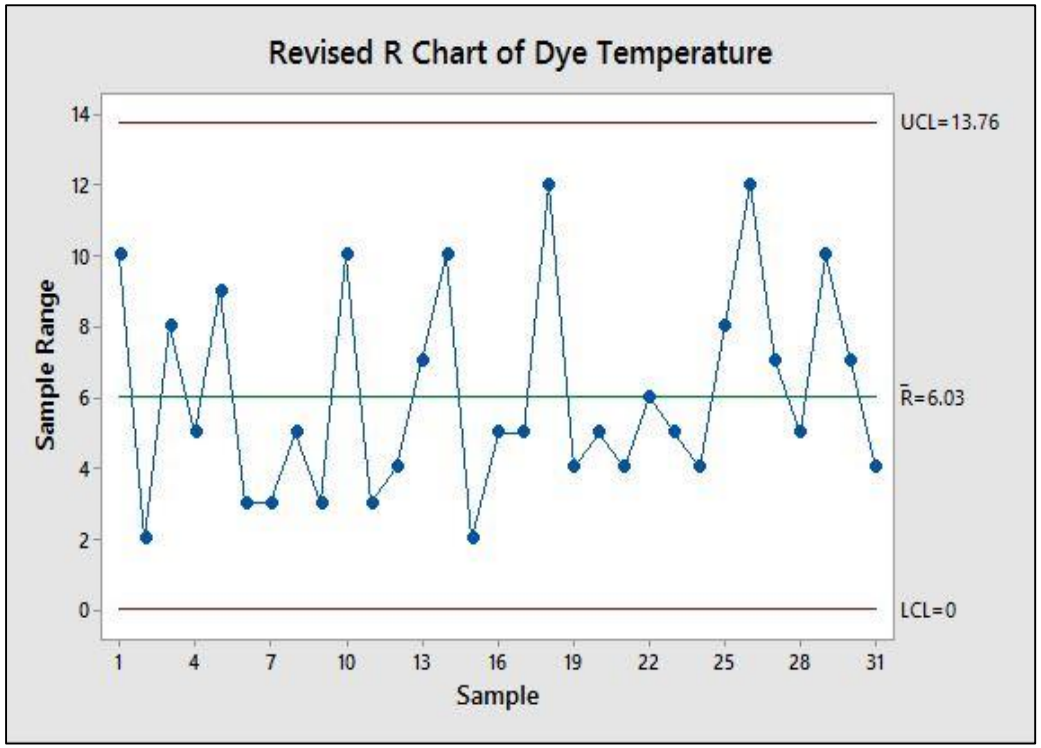
Revised



R chart (for Variables)

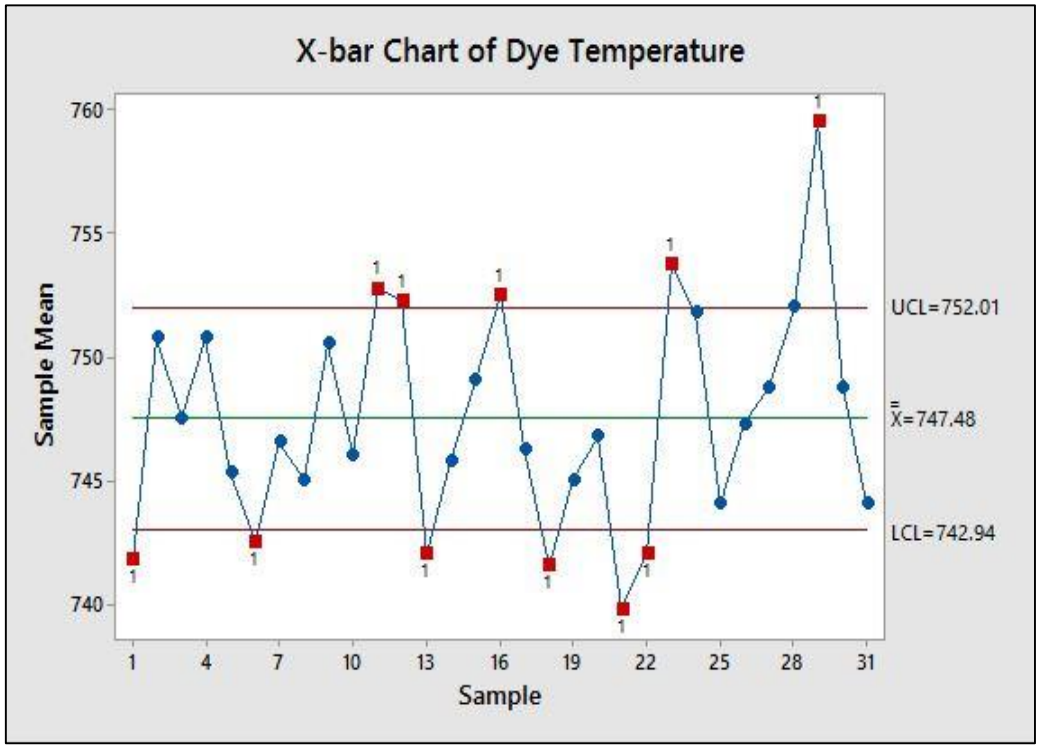
X: Dye temperature at the start of production cycle of a casting

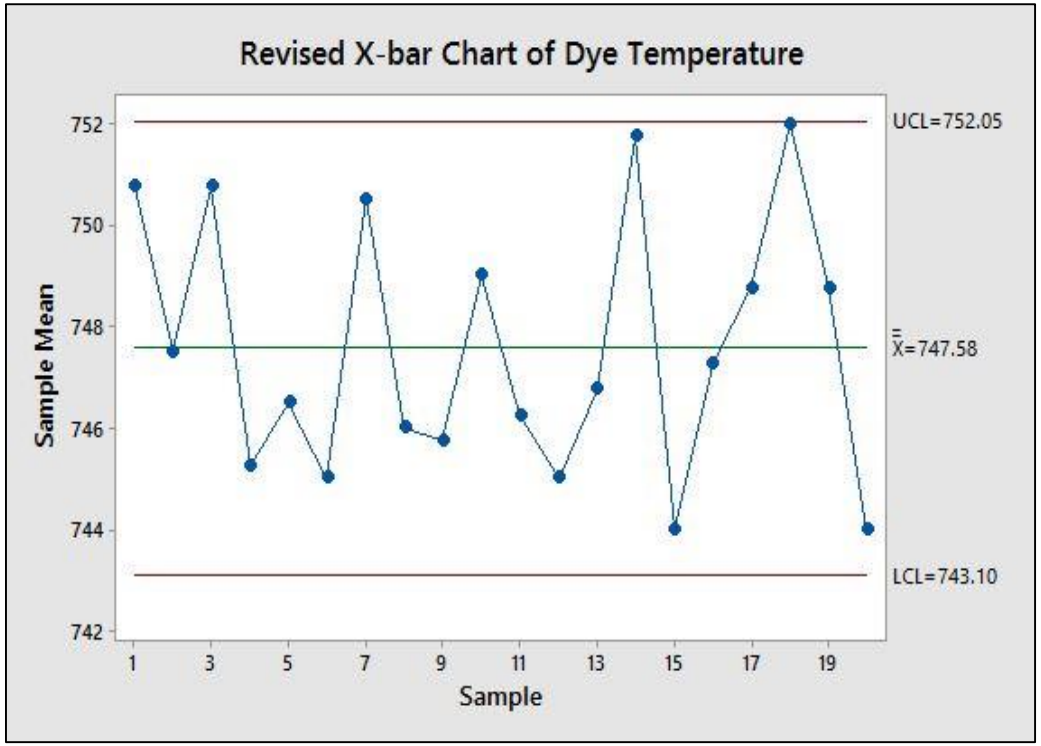




$\bar{X}$ chart

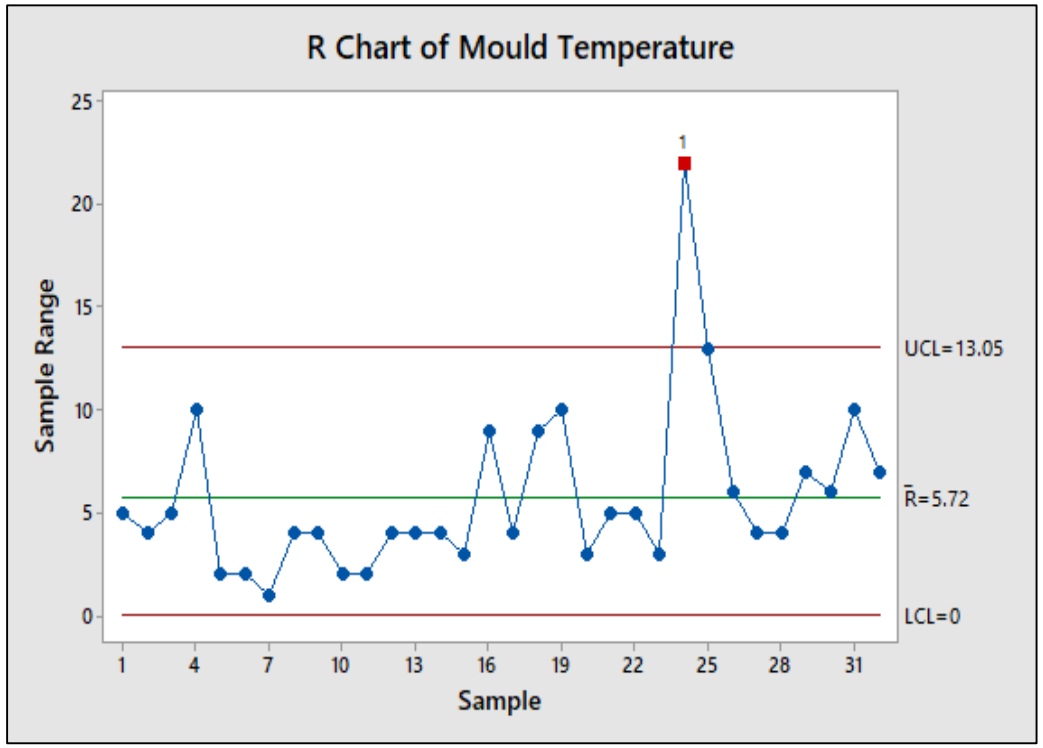
X: Dye temperature at the start of production cycle of a casting

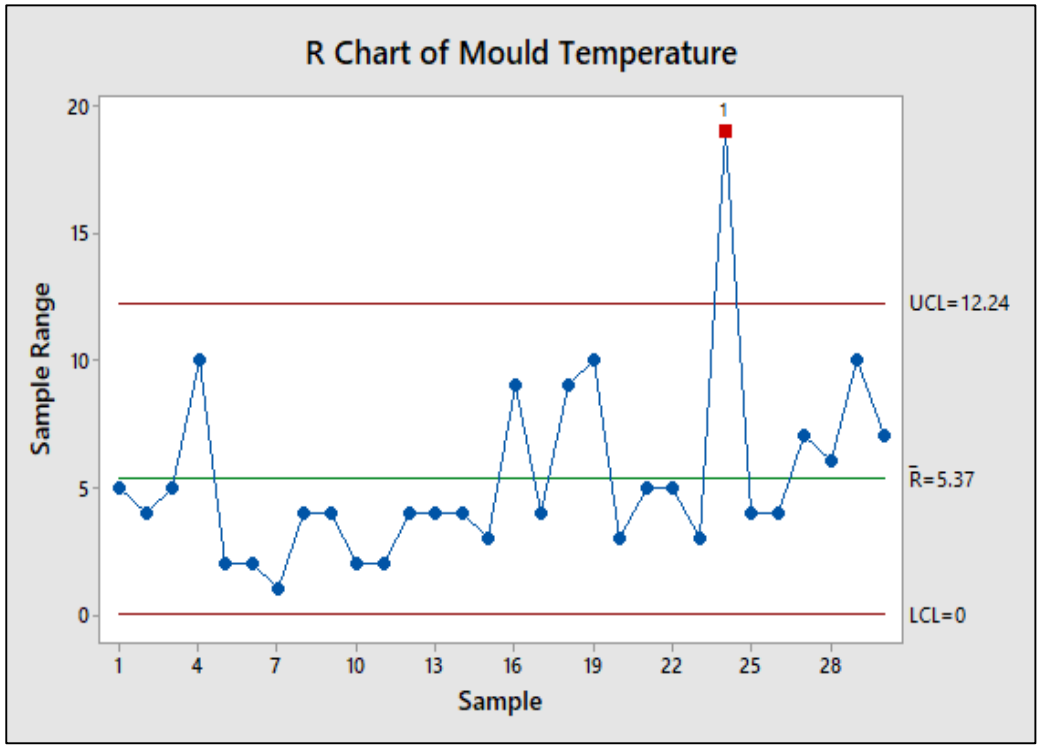




R chart

X: Mould temperature at the start of production cycle of a casting





Design of Experiments

Kruskal Wallis Test for treatment means used

Test statistic : $$H = \frac{12}{n(n+1)} \sum_j \frac{R_j^2}{n_j} - 3(n+1)$$

Here,

Treatments : Shifts A,B,C

X_{ij} = Number of defects on i^{th} day in j^{th} shift.

Mean number of defects per day for all three shifts is moderately significantly different.

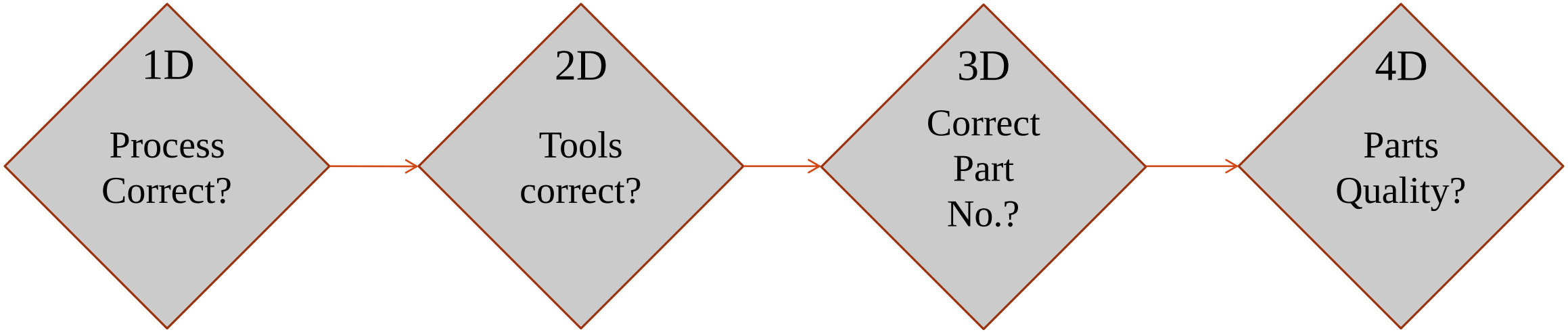
4 Diamond Process

7D Process is a systematic procedure to identify and reduce or nullify the problem.

Algorithm of 4 Diamond Process :

- Preparation of Problem Communication Brief(PCB).
- Analysis regarding questions asked in first 4 Diamonds.

4 Diamond Process



Conclusion

- Negligible but positive correlation was found in Number of items produced and number of defects per day.
- More than 80% of all defects were observed to be hole blocks.
- Hole block defects are mostly observed for those temperatures (Mould and dye) points that were out of control.
- Number of defects were observed to be moderately dependent on the shift.

Limitations and Scope

- Due to the unavailability of engineering aid, 7 Diamond process could not be applied to the data completely.
- Employing statistical quality control to a product or a process requires a lot of time which was a limitation for an academic project.

This gives scope for further studies of complicated techniques like six sigma.

THANK YOU !