

OPTIMIZING MANUFACTURING YIELD WITH MATLAB DESCRIPTIVE AND CONTROL CHARTS

1. Overview

Client:

A UK-based electronics manufacturing company specializing in printed circuit boards (PCBs)

Objective:

To assess monthly production defects and improve overall yield by using MATLAB's statistical capabilities for data validation, visualization, and quality control.

2. Background

The client's production team noticed an inconsistent yield rate over a six-month span but lacked a structured method for tracking and diagnosing the issue. They collected defect data per production batch and sought assistance in identifying patterns and process variation. MATLAB was used for its combination of statistical analysis and visualization features.

3. Data Summary

Dataset:

Defect log across 6 months, containing 1,200 batches

Key Variables:

Variable	Type	Description
Batch_ID	Nominal	Unique batch identifier
Defect_Count	Integer	Total defects observed in each batch
Units_Produced	Integer	Number of units produced per batch
Production_Line	Categorical	Line A, Line B, Line C
Supervisor	Categorical	Supervisor in charge of the shift
Date	Date	Production date

4. Methodology

Software Used:

MATLAB R2023b

Workflow:

1. Data Import & Preprocessing:

- Imported .xlsx file using readtable()
- Created new variable $\text{Defect_Rate} = \text{Defect_Count} / \text{Units_Produced}$
- Removed 3 batches with missing supervisor entries

2. Descriptive Statistics:

- Used grpstats() and summary() to compute:
 - Mean defect rates by line and month
 - Median, standard deviation, and IQR of defect rates

3. Visualization and Control Charts:

- Created time-series plot using plot() to visualize daily defect rate
- Used controlchart() from MATLAB's **Statistics and Machine Learning Toolbox** to:
 - Create X-bar and R charts by line
 - Detect batches outside control limits
- Used boxplot() to compare lines and supervisors

5. Key Results

Insight	Value
Overall Average Defect Rate	2.9%
Line A Median Defect Rate	2.1%
Line B Out-of-Control Batches	9% (highest)
Most Consistent Supervisor	Supervisor 3 (lowest IQR in defect rate)
Highest Defect Month	March (avg 4.2%)

Control Chart Findings:

- Line B had the most process instability
- 14 batches exceeded $\pm 3\sigma$ limits — 11 from Line B
- A pattern of special-cause variation linked to one weekend shift team

6. Visual Outputs (MATLAB):

- **X-bar chart** showing mean defect variation across lines
- **R chart** with range of variation per week
- **Boxplots** of defect rates by supervisor
- **Time-series plot** of daily defect rate across months

7. Deliverables

- MATLAB script files (.m) with annotated code
- Cleaned dataset in .mat and .csv formats
- 15-page analytical report including:
 - Summary statistics
 - Control chart interpretations
 - Supervisor performance comparisons
 - Recommendations
- Slide brief (3 slides):
 - Process control summary
 - Line-specific performance
 - Root cause visuals and suggestions

8. Application & Outcome

- Management used findings to re-train Line B weekend shift
- Process standardization procedures were updated for all lines
- 17% yield improvement achieved over the next quarter

- Monthly control charting adopted as part of QA routine

9. Strategic Value Delivered

- Quantified and visualized manufacturing inefficiencies
- Enabled **data-driven personnel and process adjustments**
- Provided **automatable MATLAB scripts** for monthly tracking
- Reduced waste and improved production consistency

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