

OPTIMIZING MANUFACTURING OUTPUT QUALITY USING ONE-WAY ANOVA AND CONTROL CHARTS IN MINITAB TO IDENTIFY THE BEST-PERFORMING MACHINE SETTING AMONG THREE ALTERNATIVES.

1. Background & Objectives

A mid-sized manufacturing firm was facing inconsistencies in product diameter despite standardized procedures. The objective was to test whether different machine settings were producing significantly different product qualities and to identify the most stable setting to minimize defect rates.

2. Methodology

Data Source:

Collected data on product diameter (in mm) under three machine speed settings (Low, Medium, High), with 30 samples for each setting.

Software Used:

Minitab 21

Steps Followed in Minitab:

1. Data Entry:

- Input data manually or imported from Excel as columns: SpeedSetting (categorical), Diameter (continuous).

2. Descriptive Statistics & Boxplots:

- *Stat > Basic Statistics > Display Descriptive Statistics*
- Boxplots created using *Graph > Boxplot* to visualize variation.

3. One-Way ANOVA:

- *Stat > ANOVA > One-Way ANOVA (Unstacked)*
- Assessed whether the mean diameter differs across speed settings.

4. Assumption Checks:

- Verified normality using *Graph > Probability Plot*.

- Checked equal variances with *Stat > ANOVA > Test for Equal Variances*.
- 5. **Post-hoc Testing:**
 - Tukey's HSD test performed to locate pairwise differences.
- 6. **Control Charts:**
 - Created \bar{X} and R charts using *Stat > Control Charts > Variables Charts for Subgroups* to monitor process stability.

3. Results & Interpretation

- **ANOVA F-test:**
 - p-value < 0.01 → Significant differences exist between settings.
- **Post-hoc (Tukey's HSD):**
 - High-speed setting produced significantly smaller and more consistent diameters.
- **Control Chart:**
 - High-speed setting showed lowest variation, with all data points within control limits.
- **Descriptive Stats:**
 - Mean diameters (mm): Low = 10.2, Medium = 10.0, High = 9.8
 - Standard deviation: High setting = 0.12 vs. Low = 0.28

4. Visual Outputs (Created in Minitab)

- Boxplot comparing diameters across speed settings
- One-Way ANOVA summary table
- \bar{X} and R control charts for the High-speed setting

5. Recommendations

- Standardize the use of **High-speed setting** in production.
- Conduct ongoing control chart monitoring weekly.
- Calibrate machines every 60 hours of runtime to maintain low variance.

6. Future Work

- Expand the analysis to include additional variables (e.g., ambient temperature, operator ID).
- Integrate SPC software with Minitab for real-time monitoring.
- Automate data collection using IoT-enabled machinery.

7. Stakeholder Relevance

Academic Use:

- Demonstrates application of ANOVA and quality control in industrial statistics.
- Useful for students in industrial engineering, operations research, or statistics.

Corporate Use (Manufacturing SMEs):

- Helps reduce defect rates and improve yield.
- Supports ISO/Lean Six Sigma efforts with statistically backed process improvements.