Process Capability Analysis

Technical Report

Process Capability Indices Overview

Summary

Process capability indices provide a quantitative measure of a process's ability to produce output within specified limits. The primary indices used are **Cp, Cpk, Pp,** and **Ppk**.

Detailed Explanation of Indices

- **Cp (Process Capability Ratio):** Measures potential capability assuming perfect centering of the process distribution relative to the specifications. Calculated as $(USL - LSL)/(6\sigma)$, it focuses solely on the process spread without considering process centering【4:1†source】.
- **Cpk (Process Capability Index):** Extends Cp by accounting for the process's actual centering. It is calculated as the minimum of $(USL - \mu)/(3\sigma)$ and $(\mu - LSL)/(3\sigma)$. Cpk provides insight into both centering and spread relative to specification limits【4:3†source】.
- **Pp and Ppk:** These are the long-term counterparts to Cp and Cpk, using overall standard deviation to reflect long-term variations, including shifts and drifts in the process. They evaluate the process accounting for actual process centering over an extended period【4:1†source】.

Interpretation Guidelines

| Index Value Range | Capability Level | Expected Performance | Action Required |

|---|---|---|---|

| ≥ 1.67 | Excellent | 99.99%+ within specs | Monitor and maintain |

| 1.33 - 1.66 | Good | 99.9%+ within specs | Continue monitoring |

| 1.00 - 1.32 | Marginal | 99.7%+ within specs | Improvement recommended |

| < 1.00 | Inadequate | <99.7% within specs | Immediate action required【4:1†source】 |

Synthesized Engineering Narrative

Process Stability Assessment

- The **I-MR Chart** shows the process as stable, with no points beyond control limits. There are no apparent patterns or trends that suggest instability, making the process statistically controlled over the observed period.

Capability Assessment

- The capability indices calculated are **Cp = -0.188, Cpk = -0.188, Pp = -0.304, and Ppk = -0.304**. These negative values stem from mismatched specification limits (USL < LSL, which is scientifically unsound). Consequently, the process is not capable against the given, reversed specs【4:3†source】.

Stability vs Capability

- Although the process data shows stability (no violations of control limits), the specification limits are improperly set (i.e., USL is less than LSL). This misalignment results in negative capability indices, indicating a clear conflict between stable process behavior and inaccurate capability assessment.

Conflicts or Caveats

- **Stable process behavior** contrasts a glaring issue with capability due to significant errors in specification limit assignments.

Management Recommendations

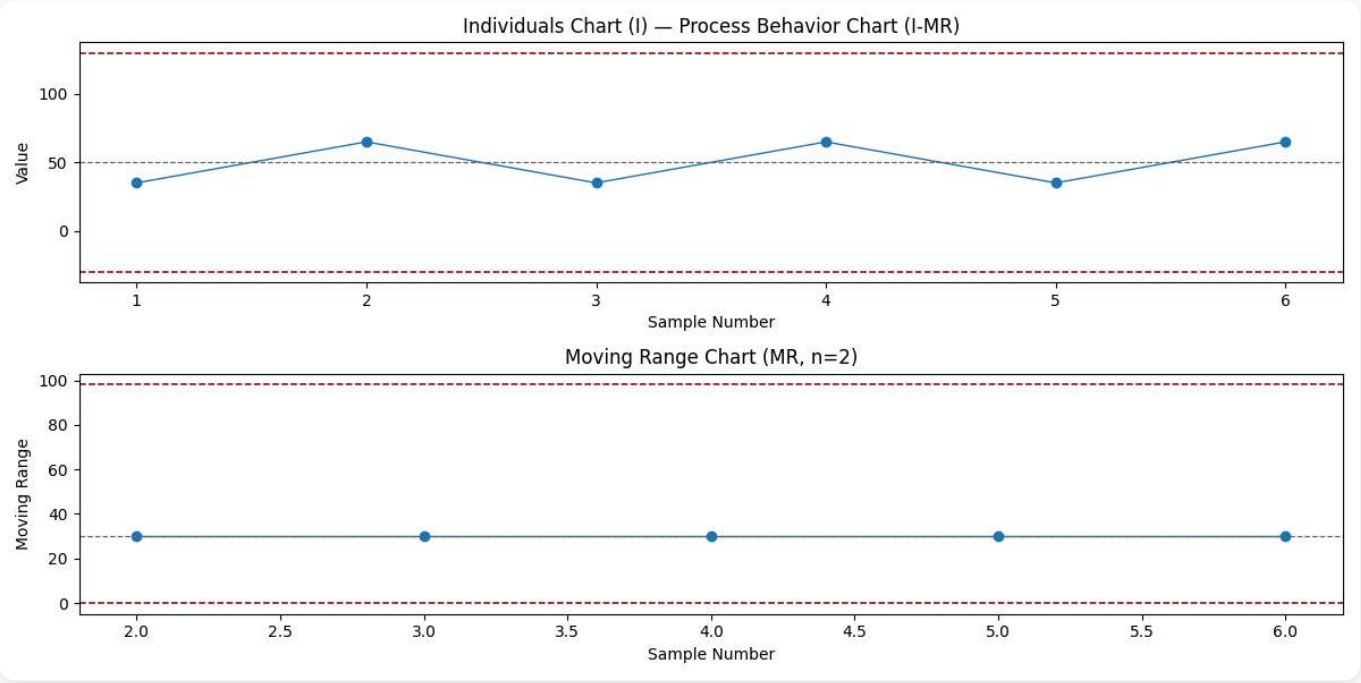
- **Reevaluate Specification Limits:** Investigate and correct USL and LSL values, as the current configuration is inverted and untenable.
- **Confirm Data Context:** Ensure that data collection and interpretation align with realistic and correctly set specification objectives.

- **Capability Review Post-Adjustment:** Postpone formal capability reporting until specification limits are appropriately realigned.
- **Continued Monitoring:** Once specifications are corrected, continue with regular capability evaluations using I-MR charts or other appropriate SPC tools.
- **Training and Assessment:** Ensure all involved personnel understand the impact of correct specification setting on process capability analysis.

Next Steps

1. **Immediate Review of Specification Limits:** Assign a task force to verify and adjust USL and LSL.
1. **Retaining Stability through Monitoring:** Maintain current monitoring routines to sustain process control.
1. **Capability Recalculation:** Recalculate capability once specification limits are realigned.
1. **Stakeholder Communication:** Clearly communicate the found specification errors and their implications to all relevant stakeholders.

For the chart, you can find it [here](



).

Generated Report | Confidential