

Evaluating Process-Control System Reliability in Rwanda

A Difference-in-Differences Methodological Framework

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ABSTRACT

Background: Process-control systems are critical for infrastructure and industrial operations, yet their reliability in developing contexts is understudied. There is a lack of robust methodological frameworks for quantitatively evaluating the impact of system upgrades or interventions on operational performance in these settings.

Purpose and objectives: This working paper proposes and details a methodological framework for the rigorous evaluation of process-control system reliability. Its objective is to provide a replicable model for assessing the causal effect of technological interventions on system uptime and failure rates.

Keywords: *Process-control systems, System reliability, Difference-in-differences, Sub-Saharan Africa, Infrastructure resilience, Developing economies, Engineering methodology*

Article Highlights

- Proposes a quasi-experimental DiD model for causal evaluation of system reliability.
- Details statistical framework with cluster-robust inference for serial correlation.
- Illustrates application via hypothetical upgrade showing 15-pp MTBF improvement.
- Emphasizes parallel trends diagnostic and longitudinal data collection needs.

Core Statistical Model

$$Y_{it} = \beta_0 + \beta_1 \text{Treat}_i + \beta_2 \text{Post}_t + \delta(\text{Treat}_i \cdot \text{Post}_t) + \varepsilon_{it}$$
where δ captures the causal treatment effect on reliability metric Y .

This is a methodological paper presenting a framework, not empirical results.

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