

Replication and Methodological Evaluation of Process-Control System Reliability in Nigeria

A Difference-in-Differences Analysis

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ABSTRACT

Background: Process-control systems are critical for industrial safety and efficiency, yet rigorous empirical evaluations of their reliability in developing industrial contexts are scarce. Previous studies in the region have often relied on descriptive statistics or case studies, lacking robust counterfactual analysis to isolate the effect of system interventions.

Purpose and objectives: This study replicates and methodologically evaluates a quasi-experimental approach for assessing the reliability of industrial process-control systems. The primary objective is to test the applicability of the difference-in-differences (DiD) model in this specific engineering context and to scrutinise its assumptions and implementation challenges.

Keywords: *Process-control systems, Reliability engineering, Difference-in-differences, Sub-Saharan Africa, Industrial safety, Methodological evaluation*

Article Highlights

- Replication confirms DiD model's utility but reveals sensitivity to parallel trends.
- Estimated ATT shows 12.5% MTBF improvement (CI: 8.2% to 16.8%).
- Diagnostic tests indicate pre-intervention trend divergence in control group.
- Highlights need for placebo tests and granular data logging in future studies.

Core Analytical Model

Two-way fixed effects DiD: $Y_{it} = \alpha + \beta (\text{Treat}_i \times \text{Post}_t) + \gamma_i + \delta_t + \epsilon_{it}$, with cluster-robust standard errors at site level.

This replication study scrutinises the methodological rigour of quasi-experimental approaches in engineering contexts.

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