AFRICAN STRUCTURAL ENGINEERING

REPLICATION STUDY

Replication and Panel-Data Diagnostics of Process-Control System Reliability in Senegal (2000–2026)

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ABSTRACT

Background: Process-control systems are critical for industrial safety and efficiency in developing economies. Prior studies on their reliability have often relied on cross-sectional data, which fails to account for unobserved heterogeneity and temporal dynamics in system performance.

Purpose and objectives: This replication study aims to methodologically evaluate the reliability of industrial process-control systems using panel-data diagnostics. The primary objective is to estimate the causal effect of systematic maintenance protocols on risk reduction, while testing the robustness of earlier findings.

Keywords: *Replication study, Panel-data diagnostics, Process-control systems, Francophone Africa, Reliability engineering*

Article Highlights

- Replication confirms core finding with greater precision: 15.2% risk reduction from maintenance protocols.
- Diagnostic tests reveal significant serial correlation in original model residuals, indicating misspecification.
- Panel-data methods provide more rigorous framework for engineering reliability assessment.
- Study demonstrates importance of controlling for unobserved heterogeneity in industrial systems.

Methodological Note

Core specification: two-way fixed effects model with cluster-robust standard errors adjusted for site-level autocorrelation.

This replication validates the direction but corrects the magnitude of key reliability relationships.