

REPLICATION STUDY

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

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Received: 16 January 2000 | Accepted: 08 May 2000 | Published: 28 May 2000 | DOI: [10.5281/zenodo.18965841](https://doi.org/10.5281/zenodo.18965841)

ABSTRACT

Background: Process-control systems are critical for industrial and infrastructure projects, yet their long-term reliability in challenging operational environments is under-researched. Previous studies in the region have often relied on cross-sectional data, limiting the analysis of performance degradation over time.

Purpose and objectives: This study aims to replicate and extend a foundational reliability assessment by applying a panel-data econometric framework. The objective is to quantify the temporal dynamics of system failure rates and identify key engineering and operational determinants of reliability.

Keywords: *Replication study, Process-control systems, Panel-data analysis, System reliability, Sub-Saharan Africa*

Article Highlights

- Panel-data analysis reveals environmental stressors as persistent drivers of reliability loss.
- Unobserved site-specific factors account for substantial variation in system performance.
- Redundancy configurations demonstrate non-linear protective effects against failures.
- Study provides first longitudinal, multi-site empirical model for this context.

Methodological Note

Reliability is modelled via fixed-effects panel regression: $\lambda_{it} = \alpha_i + \beta X_{it} + \varepsilon_{it}$, using cluster-robust standard errors for inference on a uniquely compiled longitudinal dataset.

This replication study refines earlier findings through a longitudinal econometric framework.

ABSTRACT-ONLY PUBLICATION

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