A Quasi-Experimental Evaluation of Power Distribution System Reliability in Uganda

A Methodological Framework for Infrastructure Diagnostics

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ABSTRACT

Background: Power distribution infrastructure in many developing nations faces chronic reliability challenges, yet robust methodological frameworks for its systematic diagnosis are scarce. Existing assessments often lack the rigour to isolate causal factors from observational data.

Purpose and objectives: This study develops and applies a novel quasi-experimental framework to evaluate the reliability of power-distribution equipment systems. The primary objective is to demonstrate a diagnostic methodology that quantifies failure causality and system performance under operational stresses.

Keywords: *Power distribution reliability, Infrastructure diagnostics, Quasi-experimental design, Sub-Saharan Africa, Smart grid technologies, Condition monitoring, Outage management*

Article Highlights

- Quasi-experimental design isolates causal factors in equipment failure from observational data.
- Difference-in-differences model quantifies the impact of operational stress, controlling for confounders.
- Framework provides utilities with an evidence-based tool for targeted, predictive asset management.
- Methodology moves infrastructure assessment beyond descriptive statistics to causal diagnosis.

Core Analytical Model

The study employs a difference-in-differences model: $Y\_it = \beta_0 + \beta_1 Treat\_i + \beta_2 Post\_t + \beta_3(Treat\_i \times Post\_t) + \varepsilon\_it$, with standard errors clustered at the substation level.

This study presents a methodological framework, not a nationwide reliability audit.

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