

Randomised Field Trial of Power-Distribution System Reliability

A Methodological Evaluation of Equipment in Rwanda

Jean de Dieu Niyonzima¹

University of Rwanda

Correspondence: jniyonzima@aol.com

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ABSTRACT

Background: Reliable power distribution is critical for economic development, yet many low- and middle-income countries face persistent challenges with system reliability. There is a paucity of rigorous field-based methodologies for evaluating the performance of distribution equipment in real-world, low-resource settings.

Purpose and objectives: This study aimed to develop and implement a novel randomised field trial methodology to empirically evaluate the reliability of different power-distribution equipment configurations within a national grid. The primary objective was to quantify failure rates and mean time between failures for selected apparatus.

Keywords: *Power distribution reliability, Randomised controlled trial, Sub-Saharan Africa, Grid resilience, Low-voltage networks, Field experiment, Rural electrification*

Article Highlights

- A novel randomised controlled trial methodology for evaluating distribution equipment in real-world settings.
- Manufacturer B's equipment showed a 34% lower hazard rate for catastrophic failure.
- Surge arrester failure was the most common initiating event for cascading faults.
- The study recommends incorporating randomised field testing into utility procurement validation.

Methodological Note

Reliability was modelled using Weibull survival analysis with robust standard errors to account for clustering across 150 substations.

This trial provides a rigorous framework for obtaining comparative reliability data in operational environments.

ABSTRACT-ONLY PUBLICATION

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