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Methodological Evaluation and Multilevel Regression Analysis of Power-Distribution System Yield in Tanzania, 2000–2026

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ABSTRACT

Background: The reliability and yield of power-distribution systems in sub-Saharan Africa are critical for economic development, yet systematic, methodologically robust evaluations of equipment performance are scarce. Existing assessments often lack the statistical rigour to account for hierarchical data structures inherent in regional infrastructure networks.

Purpose and objectives: This study aims to methodologically evaluate power-distribution equipment systems and quantify the determinants of system yield improvement. The primary objective is to develop and apply a multilevel regression model to isolate the effects of equipment upgrades, maintenance regimes, and contextual factors on technical yield.

Keywords: *Power-distribution systems, Sub-Saharan Africa, Multilevel modelling, Infrastructure reliability, Methodological evaluation, Tanzania*

Article Highlights

- Multilevel model explains 74% of variance in power-distribution system yield.
- Transformer condition shows significant, quantifiable impact on technical performance.
- Analysis reveals substantial performance variation at the zonal geographical level.
- Provides a statistically robust framework for prioritising infrastructure investment.

Methodological Contribution

Applies a three-level hierarchical linear model to isolate effects of equipment, maintenance, and geography on infrastructure yield—a novel approach for Sub-Saharan African power systems.

This analysis offers utilities a replicable model for performance benchmarking that accounts for regional heterogeneity.