

# Methodological Evaluation and Risk Reduction in Uganda's Power-Distribution System

*A Multilevel Regression Analysis*

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## ABSTRACT

**Background:** The reliability of power-distribution systems in many developing nations is constrained by ageing infrastructure and limited maintenance resources. A systematic, data-driven methodology for evaluating equipment performance and prioritising interventions is urgently required to enhance grid resilience.

**Purpose and objectives:** This study aims to develop and apply a novel methodological framework for the quantitative evaluation of distribution equipment risk. The primary objective is to identify the key technical and operational factors driving failure rates and to measure the potential risk reduction from targeted interventions.

**Keywords:** *Power-distribution reliability, Sub-Saharan Africa, Multilevel regression modelling, Infrastructure risk assessment, Asset management, Developing economies, Grid resilience*

### Article Highlights

- Transformer age and maintenance frequency are the most significant predictors of equipment failure.
- Regional variability accounts for approximately 15% of the total variance in failure rates.
- The study analyses a proprietary dataset of over 15,000 distribution assets in Uganda.
- The framework enables decomposition of risk within interconnected infrastructure systems.

### Methodological Insight

The core analysis employs a two-level hierarchical Poisson regression model to distinguish asset-level predictors from unobserved regional effects.

*This study presents a quantitative framework for prioritising infrastructure maintenance in developing economies.*

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