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Methodological Evaluation and Panel-Data Estimation for Power-Distribution Risk Reduction in Senegal

A Case Study, 2000–2026

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ABSTRACT

Background: Power-distribution infrastructure in many developing nations faces significant reliability and safety challenges due to ageing assets and operational stresses. A systematic, data-driven methodology for evaluating equipment risk and forecasting the impact of interventions is required to optimise capital expenditure and enhance grid resilience.

Purpose and objectives: This case study aims to develop and apply a novel methodological framework for the evaluation of power-distribution equipment. Its core objective is to estimate the causal effect of systematic equipment replacement and maintenance programmes on technical risk reduction within a national utility.

Keywords: *Power distribution, Risk reduction, Panel-data estimation, Sub-Saharan Africa, Infrastructure reliability, Ageing assets, Methodological evaluation*

Article Highlights

- Panel-data model quantifies causal effect of maintenance on risk reduction.
- Identifies transformer overloading and environmental corrosion as dominant residual risks.
- Provides evidence-based framework for prioritising infrastructure investment.
- Recommends increased sensor deployment to refine predictive models.

Methodological Contribution

Develops a novel panel-data econometric framework integrating technical failure data, environmental variables, and maintenance records to evaluate equipment risk and forecast intervention impacts.

This case study offers a replicable model for data-driven infrastructure management in developing contexts.