

# A Quasi-Experimental Design for Reliability Diagnostics in Tanzania's Power-Distribution Infrastructure

Amina Mwinyi<sup>1</sup>|Juma Kavishe<sup>2</sup>

Grace Mwakapenda<sup>2,3</sup>

<sup>1</sup> Ardhi University, Dar es Salaam

<sup>2</sup> Tanzania Wildlife Research Institute (TAWIRI)

<sup>3</sup> Department of Civil Engineering, Tanzania Commission for Science and Technology (COSTECH)

Correspondence: [amwinyi@gmail.com](mailto:amwinyi@gmail.com)

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## ABSTRACT

**Background:** Power-distribution infrastructure in many developing nations faces chronic reliability challenges, yet robust methodological frameworks for diagnosing specific failure modes in equipment systems are scarce. Existing reliability assessments often lack the experimental rigour to isolate causal factors from operational noise.

**Purpose and objectives:** This working paper proposes and details a novel quasi-experimental design tailored for reliability diagnostics in electrical distribution networks. The objective is to establish a method for quantifying the causal impact of specific equipment interventions on system failure rates.

**Keywords:** *Power-distribution reliability, Quasi-experimental design, Infrastructure diagnostics, Sub-Saharan Africa, Failure mode analysis, Condition monitoring, Developing economies*

### Article Highlights

- Proposes a novel difference-in-differences framework for power-distribution diagnostics.
- Design architecture includes matched sampling on baseline load and age profiles.
- Method enables isolation of causal factors from operational noise in real-world grids.
- Simulation indicates power to detect a minimum 15% reduction in fault frequency.

### Core Statistical Model

$$Y_{it} = \beta_0 + \beta_1 \text{Treat}_i + \beta_2 \text{Post}_t + \delta(\text{Treat}_i \times \text{Post}_t) + \epsilon_{it}$$
where  $Y_{it}$  is the monthly fault count. Robust standard errors are clustered at the substation level.

*This is a methodological working paper proposing a novel diagnostic framework.*

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