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Replication and Refinement of a Bayesian Hierarchical Model for Risk Reduction in Ghana's Power-Distribution Asset Management

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ABSTRACT

Background: Asset management for electrical power-distribution networks in developing economies requires robust, data-driven risk-assessment frameworks. A previously proposed Bayesian hierarchical model offered a novel approach for quantifying risk reduction from maintenance interventions on equipment such as transformers and circuit breakers.

Purpose and objectives: This study aimed to replicate the methodological evaluation of the Bayesian hierarchical model for power-distribution asset management, assessing its reproducibility and refining its application to enhance operational decision-making for infrastructure in Ghana.

Keywords: *Bayesian hierarchical modelling, asset management, power-distribution networks, Sub-Saharan Africa, risk assessment, replication study*

Article Highlights

- Replication confirms core model functionality for asset risk assessment.
- Reveals critical sensitivity of failure rate estimates to hyperprior choice.
- Credible interval widths varied by up to 40% under different priors.
- Highlights need for careful prior elicitation for actionable risk metrics.

Refinement Note

The original Bayesian hierarchical model is methodologically sound but requires empirically informed hyperpriors, developed through expert judgement and historical data, for reliable deployment.

This replication study validates and refines a risk-assessment model for practical infrastructure management.