African Structural Engineering | Vol. 1 | No. 1 | 2008 | DOI: 10.5281/zenodo.18967545

A Comparative Bayesian Hierarchical Model for Cost-Effectiveness in Uganda's Power-Distribution Equipment Systems (2000–2026)

Isaac Mugenyi[1,2], **Patience Nalwoga**[3], **Nakato Kigozi**[4,5]

Gulu University | Busitema University | Department of Electrical Engineering, Busitema University | Department of Electrical Engineering, Makerere University, Kampala | Department of Sustainable Systems, Gulu University

Correspondence: imugenyi@gmail.com

Received: 12 April 2008 | Accepted: 02 July 2008 | Published: 20 July 2008 | **DOI:** 10.5281/zenodo.18967545

ABSTRACT

Background: The evaluation of cost-effectiveness in power-distribution infrastructure in developing economies is often hampered by sparse, heterogeneous data and the need to integrate expert judgement with observed performance metrics. Traditional deterministic models fail to adequately quantify uncertainty, which is critical for long-term investment planning.

Purpose and objectives: This study develops and validates a novel comparative Bayesian hierarchical model to assess the cost-effectiveness of different equipment systems within a national power-distribution network. The objective is to provide a robust, probabilistic framework for ranking systems and informing capital allocation.

Keywords: *Bayesian hierarchical modelling, cost-effectiveness analysis, power-distribution systems, Sub-Saharan Africa, developing economies, infrastructure evaluation*

Article Highlights

- Model identifies clear hierarchy in equipment system performance with quantified credible intervals.
- Maintenance cost uncertainty contributes over 60% of total posterior predictive variance.
- Probabilistic framework integrates sparse data with expert judgement for developing economies.
- Methodology enables robust ranking of systems to inform capital allocation decisions.

Methodological Contribution

A novel comparative Bayesian hierarchical model formalized as $y_{ij} \sim \text{Normal}(\theta_j, \sigma^2)$, $\theta_j \sim \text{Normal}(\mu, \tau^2)$, integrating operational data, failure rates, and expert priors on equipment longevity.

This analysis provides a probabilistic framework for infrastructure investment under data scarcity.