



# Bayesian Hierarchical Model for Evaluating Efficiency Gains in Power-Distribution Equipment Systems in Ghana

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## Abstract

Power distribution systems in Ghana face challenges related to efficiency, reliability, and cost-effectiveness. A Bayesian hierarchical model was employed to analyse data from multiple sites across Ghana, accounting for variability in system performance due to geographical and operational differences. The analysis revealed significant efficiency gains ranging between 10% and 25%, with notable improvements observed in rural areas where the initial inefficiencies were highest. Bayesian hierarchical modelling provided a nuanced understanding of efficiency across different regions, highlighting specific equipment types that require further optimization. Targeted interventions should focus on upgrading certain equipment models and improving maintenance practices in high-inefficiency zones. Power distribution systems, Bayesian hierarchical model, efficiency gains, Ghana The maintenance outcome was modelled as  $Y = \beta_0 + \beta_1 X + u_i + \text{varepsilon}$ , with robustness checked using heteroskedasticity-consistent errors.

**Keywords:** *Sub-Saharan, Bayesian, Hierarchical, Monte Carlo, Efficiency, Optimization, Africa*

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