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Bayesian Hierarchical Model for Evaluating Cost-Effectiveness in Power-Distribution Equipment Systems: A Nigerian Perspective

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Abstract

Power distribution equipment systems in Nigeria are critical for ensuring reliable electricity supply to various sectors. However, these systems often face challenges related to cost-effectiveness and maintenance needs. A Bayesian hierarchical model was employed to analyse data from multiple distribution points across different regions in Nigeria. This approach allows for the integration of site-specific variability with aggregated information, providing a comprehensive evaluation of cost-effectiveness. The analysis revealed significant variations in equipment efficiency and maintenance costs across different geographical areas, highlighting the need for targeted interventions and standardised practices to enhance overall system performance. The Bayesian hierarchical model demonstrated its effectiveness in quantifying cost-effectiveness metrics with high precision, offering valuable insights for policymakers and stakeholders aiming to optimise power distribution infrastructure in Nigeria. Based on the findings, recommendations include implementing a regional maintenance strategy aligned with equipment efficiency data, and promoting standardised operational protocols across the country. The maintenance outcome was modelled as $Y\{\} = beta\,0 + beta\,1\,X\{\} + ui + varepsilon\{\}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *Bayesian statistics, Hierarchical modelling, Markov Chain Monte Carlo, Cost-effectiveness analysis, African engineering, Econometrics, Optimization techniques*

ABSTRACT-ONLY PUBLICATION

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