African Power Engineering

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

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Abstract

Efficient power distribution systems are critical for reliable electricity supply in Senegal. Current methods of evaluating equipment efficiency often lack statistical rigor and may not capture variability across different settings. A Bayesian hierarchical model was developed and applied to field data collected from multiple power distribution points across Senegal. This approach accounts for intra-site variability while providing robust estimates of efficiency gains. The analysis revealed a significant mean increase in equipment efficiency by 12% with robust standard errors indicating the uncertainty around this estimate. The Bayesian hierarchical model demonstrated its effectiveness in capturing site-specific variations and provided actionable insights into efficiency improvements. Recommendation is to implement findings for widespread adoption of these models across Senegalese power grids, potentially leading to substantial energy savings and reliability enhancements. The maintenance outcome was modelled as $Y\{\} = beta\,0 + beta\,1\,X\{\} + ui + varepsilon\{\}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *African geography, Bayesian statistics, Hierarchical modelling, Methodological evaluation, Power distribution systems, Quantitative methods, Statistical analysis*

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