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Bayesian Hierarchical Model for Evaluating Power-Distribution Equipment Systems in Rwanda

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Abstract

Power distribution systems are critical for ensuring reliable electricity supply in Rwanda's growing economy. A Bayesian hierarchical model will be employed to analyse data from multiple PDE installations in Rwanda. The model will account for spatial variability by incorporating regional-specific parameters and allow for uncertainty quantification through credible intervals. The analysis revealed significant differences in the efficiency of PDE systems across regions, with a notable improvement observed in urban areas compared to rural settings. Bayesian hierarchical modelling provided valuable insights into optimising power distribution infrastructure in Rwanda by identifying cost-effective solutions for different geographical locations. Investment strategies should prioritise urban areas where the model predicts higher efficiency and lower costs of PDE systems, facilitating sustainable electricity access. The maintenance outcome was modelled as $Y\{\} = beta\,0 + beta\,1\,X\{\} + ui + varepsilon\{\}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *Rwanda, Hierarchical Models, Bayesian Methods, Monte Carlo Simulations, Cost-Benefit Analysis, Econometrics, Geographic Information Systems (GIS)*

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