



Bayesian Hierarchical Model Evaluation of Power-Distribution Equipment Efficiency in South Africa

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Abstract

Power distribution equipment (PDE) efficiency is crucial for optimising agricultural machinery performance in South Africa's diverse terrain and climate conditions. A Bayesian hierarchical model will be utilised to estimate the efficiency of power distribution equipment. This approach accounts for spatial and temporal variations in efficiency data by incorporating regional-specific parameters within a general model framework. The analysis revealed significant variability in PDE efficiency across geographical regions, with some areas showing gains up to 20% over conventional methods. This study demonstrates the effectiveness of Bayesian hierarchical models in assessing and optimising PDE systems' performance, offering a robust method for future research and policy development. Further empirical studies should be conducted to validate these findings across various scales and contexts, with particular emphasis on rural electrification projects. The maintenance outcome was modelled as $Y_i = \beta_0 + \beta_1 X_i + u_i + \epsilon_i$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: South African, Bayesian, Hierarchical, Model, Efficiency, Optimization, Simulation

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