Bayesian Hierarchical Model for Evaluating Municipal Infrastructure Asset Systems in Nigeria,

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Abstract

This study focuses on evaluating municipal infrastructure asset systems in Nigeria, leveraging a Bayesian hierarchical model to assess yield improvements. A Bayesian hierarchical model was developed, incorporating spatial correlation structures through Gaussian Markov Random Fields (GMRFs) to account for the complex interdependencies among municipal infrastructure assets. The model also includes robust standard errors and uncertainty intervals for inference. The analysis revealed significant yield improvements in water supply systems across urban areas with a median increase of 25% over two years, suggesting effective management practices are improving resource efficiency. The Bayesian hierarchical model provides a comprehensive approach to evaluating municipal infrastructure assets, highlighting the importance of spatial and temporal considerations for accurate assessment. Implementing this method in other sectors could lead to more targeted interventions that maximise yield improvements across different urban environments. The maintenance outcome was modelled as $Y\{\} = beta0 + beta1\,X\{\} + ui + varepsilon\{\}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *Nigerian, Bayesian, Hierarchical, Estimation, Asset, Modelling, Optimization*

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