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Methodological Evaluation of Municipal Infrastructure Assets Systems Using Bayesian Hierarchical Models in South Africa

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Abstract

Municipal infrastructure assets in South Africa are critical for urban development and economic growth, yet their management is often inefficient due to inadequate data and analytical tools. The study applied BHM to model municipal infrastructure asset systems. Specific attention was given to the structure of the models, including hyperpriors for uncertainty quantification. A key finding revealed that incorporating spatial dependencies significantly improved model accuracy in predicting asset condition and maintenance costs across different regions. Bayesian hierarchical models provided a robust framework for evaluating municipal infrastructure systems and identified opportunities for efficiency improvements through targeted interventions. Municipalities should consider integrating BHM into their asset management strategies to enhance decision-making processes and resource allocation. The maintenance outcome was modelled as $Y\{\} = beta0 + beta1\,X\{\} + ui + varepsilon\{\}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *Sub-Saharan, Bayesian, Hierarchical, Estimation, Asset Management, Econometrics, Efficiency*

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