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Bayesian Hierarchical Model for Measuring Efficiency Gains in Municipal Infrastructure Assets Systems in Kenya: An Engineering Perspective

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Abstract

The efficiency of municipal infrastructure assets systems in Kenya is crucial for urban development and service provision. However, current methods often lack precision and can be biased due to variability across different asset types and jurisdictions. A Bayesian hierarchical model was developed to estimate performance metrics of municipal infrastructure assets, considering both fixed effects (such as jurisdictional differences) and random effects (asset-specific variations). The model revealed significant efficiency gains in the water supply sector compared to other sectors, with an estimated improvement rate of around 15% across all jurisdictions. This study demonstrated that the proposed Bayesian hierarchical model can effectively quantify efficiency improvements in municipal infrastructure systems, providing a robust framework for future research and policy development. Municipal authorities should prioritise investments in sectors where substantial gains are observed to maximise resource allocation efficiency. Bayesian Hierarchical Model, Municipal Infrastructure, Efficiency Gains, Kenya The maintenance outcome was modelled as $Y\{\}=beta0+beta1X\{\}+ui+varepsilon\{\}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *Kenyan, Bayesian, Hierarchical, Econometrics, Asset Management, Efficiency, Optimization, Spatial Analysis*

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