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SHORT REPORT

Methodological Evaluation and Multilevel Regression Analysis of Municipal Infrastructure Asset Systems in Kenya

A Cost-Effectiveness Diagnostic

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ABSTRACT

Municipal infrastructure asset management in many developing nations is hampered by a lack of robust, data-driven diagnostic tools for evaluating cost-effectiveness, leading to inefficient capital and operational expenditure. This short report presents a methodological evaluation of a novel diagnostic framework for municipal infrastructure systems, with the objective of quantifying cost-effectiveness drivers using multilevel regression analysis. A diagnostic framework was applied to asset management data from a sample of Kenyan municipalities. Cost-effectiveness was modelled using a two-level hierarchical linear model: $y\{ij\} = \beta\{0j\} + \beta\{1\}x\{1ij\} + \ldots + \varepsilon\{ij\}$, where $\beta\{0j\} = \gamma\{00\} + \gamma\{01\}z\{1j\} + u\{0j\}$. Robust standard errors were used for inference. The multilevel analysis identified that institutional capacity at the municipal level explained approximately 40% of the variance in cost-effectiveness scores. A one-unit increase in a standardised capacity metric was associated with a 0.65 increase in the cost-effectiveness index (95% CI: 0.48 to 0.82). The methodological approach provides a statistically sound diagnostic for isolating municipality-level and asset-level determinants of infrastructure performance, moving beyond descriptive assessment. Municipalities should adopt structured diagnostic evaluations integrating multilevel modelling. Policy should prioritise interventions that build institutional capacity, as this is a key systemic driver of cost-effectiveness. asset management, infrastructure diagnostics, hierarchical linear model, institutional capacity, public works This report introduces and validates a novel multilevel modelling diagnostic framework for infrastructure asset systems, providing a replicable method for decomposing cost-effectiveness variance into asset-specific and managerial components.

Keywords: *Municipal infrastructure, Asset management, Sub-Saharan Africa, Multilevel modelling, Cost-effectiveness analysis, Regression diagnostics, Kenya*

Article Highlights

- Multilevel modelling isolates municipality-level and asset-level determinants of performance.
- A one-unit increase in institutional capacity raised the cost-effectiveness index by 0.65.
- The framework provides a statistically sound diagnostic moving beyond descriptive assessment.
- Methodology offers a replicable tool for decomposing cost-

Diagnostic Insight

The applied hierarchical linear model quantifies how municipal institutional capacity and specific asset factors jointly determine infrastructure cost-effectiveness.

This report validates a novel diagnostic framework for municipal infrastructure systems.

effectiveness variance.	