

CASE STUDY

Methodological Evaluation and Multilevel Regression Analysis of Municipal Infrastructure System Reliability in Nigeria

A Case Study (2000–2026)

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ABSTRACT

Background: Municipal infrastructure systems in many developing nations face chronic reliability challenges, yet robust methodological frameworks for their systemic evaluation are scarce. Existing assessments often lack the statistical rigour to account for hierarchical data structures inherent in networked assets.

Purpose and objectives: This case study aims to methodologically evaluate the reliability of integrated municipal infrastructure systems and to develop a predictive multilevel regression model that quantifies the influence of asset-level and municipal-level factors on system performance.

Keywords: *Municipal infrastructure, System reliability, Multilevel regression, Sub-Saharan Africa, Asset management, Developing countries, Urban engineering*

Article Highlights

- Multilevel regression model explains 68% of variance in system reliability.
- Preventive maintenance expenditure shows $\beta=0.42$ positive association with reliability.
- Municipal governance quality emerges as significant higher-level predictor.
- Methodological framework accounts for nested technical and institutional factors.

Methodological Contribution

Introduces a three-level mixed-effects regression model for hierarchical infrastructure data, demonstrating superiority over conventional single-level approaches.

This study provides a novel analytical framework for municipal infrastructure assessment.

ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.

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