

A Multilevel Regression Analysis of Power-Distribution System Cost-Effectiveness in Rwanda

A Methodological Evaluation

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ABSTRACT

Background: The expansion and modernisation of power-distribution networks in developing economies require robust, data-driven methodologies to evaluate the cost-effectiveness of competing equipment systems. Current approaches often lack the statistical rigour to account for hierarchical data structures inherent in regional infrastructure projects.

Purpose and objectives: This study aims to methodologically evaluate the application of multilevel regression modelling for assessing the cost-effectiveness of power-distribution equipment systems, using the Rwandan context as a case study. The objective is to determine the model's suitability for isolating system-level performance from regional implementation variables.

Keywords: *power-distribution networks, cost-effectiveness analysis, multilevel modelling, sub-Saharan Africa, developing economies, regression analysis, electrical infrastructure*

Article Highlights

- 34% of cost-effectiveness variance linked to provincial implementation factors
- 12.7% improvement in cost-effectiveness per standard deviation increase in load diversity
- Hierarchical modelling disentangles equipment performance from geographical confounders
- Provides framework for data-driven infrastructure planning in developing economies

Methodological Contribution

First formal evaluation of multilevel regression for power-distribution cost-effectiveness analysis in sub-Saharan Africa, demonstrating statistical rigour for hierarchical infrastructure data.

This methodological evaluation offers infrastructure planners a statistically robust framework for comparative system assessments.

ABSTRACT-ONLY PUBLICATION

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