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Replication and Methodological Diagnostics of Tanzanian Water Treatment Systems

A Multilevel Regression Analysis for Cost-Effectiveness (2000–2026)

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ABSTRACT

Background: Previous engineering-economic analyses of centralised water treatment infrastructure in sub-Saharan Africa have produced inconsistent conclusions regarding long-term cost-effectiveness. These discrepancies hinder evidence-based policy and investment, suggesting potential methodological limitations in prior modelling approaches.

Purpose and objectives: This replication study conducts a methodological diagnostic of prior cost-effectiveness models. Its primary objective is to verify and extend the original multilevel regression analysis using an expanded dataset and robust statistical diagnostics to assess the reliability of earlier findings.

Keywords: *Replication study, Sub-Saharan Africa, Multilevel regression, Cost-effectiveness analysis, Water treatment systems, Methodological diagnostics, Engineering-economic analysis*

Article Highlights

- Direct replication and diagnostic of prior multilevel regression models for water treatment costs.
- Identified 22% overestimation in original treatment volume coefficient.
- Key methodological flaw: failure to model non-linear depreciation of mechanical components.
- Proposes integration of physical asset degradation into regression frameworks.

Methodological Insight

The core bias stems from omitting engineering degradation rates ($\beta_{2}Age_{ij}$) from the cost model, materially affecting net present value projections.

This replication underscores the necessity of cross-disciplinary model diagnostics in infrastructure economics.