AFRICAN STRUCTURAL ENGINEERING

ISSN: XXXX-XXXX | Peer-Reviewed | Open Access

Replication and Multilevel Regression Analysis of Municipal Infrastructure System Reliability in Senegal

A Methodological Evaluation (2000–2026)

DOI: 10.5281/zenodo.18971624 | **Received:** 14 May 2004 | **Accepted:** 04 August 2004 | **Published:** 08 September 2004

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DOI: 10.5281/zenodo.18971624

Received: 14 May 2004 | Accepted: 04 August 2004

ABSTRACT

Background: Municipal infrastructure system reliability in West Africa is a critical engineering concern, yet methodological approaches for its assessment are often inconsistent. Previous studies have applied multilevel regression models, but their replicability and the robustness of their inferences in this specific context remain unverified.

Purpose and objectives: This study aims to methodologically evaluate the replication of a seminal multilevel regression analysis for measuring infrastructure system reliability. The objective is to test the robustness of the original model's specifications and to assess the stability of its parameter estimates when applied to an expanded dataset.

Keywords: *Municipal infrastructure, System reliability, Multilevel regression, West Africa, Replication study*

Article Highlights

- Direct replication confirms governance capacity as significant predictor ($p < 0.01$).
- Asset age effect 40% smaller in extended analysis, confidence interval includes zero.
- Core methodological framework sound but parameter estimates show context sensitivity.
- Recommends rolling-window validation for future infrastructure reliability models.

Methodological Insight

The study demonstrates that while multilevel regression provides a sound framework for infrastructure reliability analysis, critical parameter estimates require stability testing across temporal and spatial data extensions.

This replication study stresses the importance of methodological robustness for engineering policy.

ABSTRACT-ONLY PUBLICATION

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