

ORIGINAL RESEARCH

# A Bayesian Hierarchical Model for the Efficiency Diagnostics of Municipal Infrastructure Asset Systems in Uganda

Kato Muwanga<sup>1</sup>

<sup>1</sup> Kampala International University (KIU)

Correspondence: [kmuwanga@yahoo.com](mailto:kmuwanga@yahoo.com)

Received: 24 January 2000 | Accepted: 23 February 2000 | Published: 16 March 2000 | DOI:

[10.5281/zenodo.18966165](https://doi.org/10.5281/zenodo.18966165)

## ABSTRACT

**Background:** Municipal infrastructure asset systems in many developing nations face chronic inefficiencies, yet robust, data-driven diagnostic tools for their evaluation are scarce. Existing methods often fail to account for the hierarchical structure of asset data and inherent uncertainties in performance measurement.

**Purpose and objectives:** This study aimed to develop and validate a novel Bayesian hierarchical model to diagnose the technical efficiency of municipal infrastructure systems, providing a probabilistic framework for identifying performance drivers and potential gains.

**Keywords:** *Bayesian hierarchical modelling, municipal infrastructure, asset management, efficiency diagnostics, Sub-Saharan Africa*

### Article Highlights

- Bayesian hierarchical model quantifies municipal infrastructure efficiency with probabilistic uncertainty.
- Governance quality shows strongest effect on performance, with 95% credible interval [0.15, 0.31].
- Systemic underperformance is prevalent and linked to institutional rather than technical constraints.
- Probabilistic diagnostics enable targeted interventions for greatest marginal efficiency gains.

### Methodological Innovation

A Bayesian stochastic frontier model ( $\ln(y_{ij}) = \beta_0 + \beta X_{ij} + v_{ij} - u_{ij}$ ) applied to a unique panel dataset of water, road, and drainage assets across multiple municipalities.

*This study provides a novel probabilistic framework for diagnosing municipal infrastructure efficiency in developing contexts.*

## **ABSTRACT-ONLY PUBLICATION**

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

## **REQUEST FULL PAPER**

 **Email:** [info@parj.africa](mailto:info@parj.africa)

Request your copy of the full paper today!

## **SUBMIT YOUR RESEARCH**

**Are you a researcher in Africa? We  
welcome your submissions!**

Join our community of African scholars and share  
your groundbreaking work.

 **Submit at:** [app.parj.africa](http://app.parj.africa)



Scan to visit [app.parj.africa](http://app.parj.africa)

### **Open Access Scholarship from PARJ**

Empowering African Research | Advancing Global  
Knowledge