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A Bayesian Hierarchical Model for Risk Reduction in Tanzanian Municipal Infrastructure Asset Management Systems

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ABSTRACT

Background: Municipal infrastructure asset management in developing nations is challenged by data scarcity and high uncertainty, leading to inefficient resource allocation and heightened risk of asset failure. Current deterministic models often fail to capture the complex, multi-level uncertainties inherent in such contexts.

Purpose and objectives: This study develops and evaluates a novel probabilistic framework to quantify risk reduction within municipal infrastructure asset management systems. Its objective is to provide a robust method for prioritising maintenance interventions under uncertainty.

Keywords: *Bayesian hierarchical modelling, risk reduction, municipal infrastructure, asset management systems, Sub-Saharan Africa, developing nations, uncertainty quantification*

Article Highlights

- Quantifies risk reduction in data-scarce municipal asset management systems.
- Integrates sparse field data with expert judgement using Bayesian inference.
- Demonstrates a 40% reduction in predictive uncertainty for asset failure.
- Provides a statistically rigorous framework for defensible investment decisions.

Methodological Contribution

A novel Bayesian hierarchical model that formally incorporates multi-level uncertainties for infrastructure condition forecasting in developing contexts.

This study offers a transferable probabilistic framework for asset management under uncertainty.

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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