AFRICAN CIVIL ENGINEERING JOURNAL
Vol. 1 | No. 1 | 2017 | 10.5281/zenodo.18973600

A Bayesian Hierarchical Model for Risk Reduction in Ghanaian Transport Maintenance Depot Systems

A Methodological Case Study

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Received: 29 May 2017 | Accepted: 14 August 2017 | Published: 12 September 2017 | **DOI:** 10.5281/zenodo.18973600

ABSTRACT

Background: Transport maintenance depot systems in developing nations face complex, multi-faceted risks that challenge conventional risk assessment frameworks. Existing methodologies often fail to adequately capture the hierarchical nature of operational data and the inherent uncertainty in sparse datasets typical of such contexts.

Purpose and objectives: This case study presents a methodological evaluation of a novel Bayesian hierarchical model designed to quantify risk reduction within transport maintenance depot systems. The objective is to demonstrate a robust framework for integrating disparate data sources to inform infrastructure management decisions.

Keywords: *Bayesian hierarchical modelling, risk reduction, transport maintenance, depot systems, Sub-Saharan Africa, developing countries, engineering case study*

Article Highlights

- Quantifies a 34% median reduction in high-priority failure risk post-intervention.
- Hierarchical structure reveals significant depot-level variability in risk drivers.
- Handles sparse, multi-source data typical of developing nation contexts.
- Provides statistically robust uncertainty estimates via credible intervals.

Core Methodological Contribution

A Bayesian hierarchical model that integrates disparate operational data to quantify risk reduction and depot variability in maintenance systems, offering superior handling of uncertainty compared to deterministic frameworks.

This case study presents a novel methodological framework, not a broad empirical survey.