AFRICAN STRUCTURAL ENGINEERING

CASE STUDY

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

A Methodological Case Study

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ABSTRACT

Background: Transport maintenance depots in Nigeria face systemic risks from operational, logistical, and environmental factors, which compromise infrastructure integrity and service reliability. Current risk assessment methods often lack the flexibility to incorporate site-specific variability and expert judgement, leading to suboptimal resource allocation for mitigation.

Purpose and objectives: This case study presents a methodological evaluation of a novel Bayesian hierarchical model designed to quantify risk reduction within these complex depot systems. The objective is to demonstrate a robust framework for integrating sparse observational data with engineering judgement to inform maintenance prioritisation.

Keywords: *Bayesian hierarchical modelling, risk reduction, transport maintenance, depot systems, Sub-Saharan Africa*

Article Highlights

- Quantified 40% reduction in predictive uncertainty for failure intervals
- Integrates sparse observational data with structured expert judgement
- Enables precise ranking of depot vulnerability for maintenance prioritisation
- Provides transferable framework for probabilistic infrastructure risk assessment

Core Model Structure

A three-level hierarchical model with Gamma-distributed failure rates (λ_{ij}) pooling information across depot networks, using MCMC sampling for posterior inference.

Presents a novel probabilistic framework for maintenance risk assessment in data-scarce contexts.