

# A Bayesian Hierarchical Modelling Framework for Evaluating Transport Depot Maintenance System Adoption in Tanzania

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## ABSTRACT

**Background:** The performance of transport infrastructure in many developing nations is critically dependent on the efficacy of maintenance depot systems. However, evaluating the adoption and effectiveness of such systems remains methodologically challenging, often relying on aggregated metrics that mask regional and operational heterogeneity.

**Purpose and objectives:** This article presents a novel Bayesian hierarchical modelling framework designed to rigorously evaluate the adoption rates of transport depot maintenance systems. The objective is to provide a robust methodological tool that quantifies adoption while accounting for multi-level variability inherent in national infrastructure networks.

**Keywords:** *Bayesian hierarchical modelling, transport infrastructure maintenance, Sub-Saharan Africa, adoption evaluation, maintenance depot systems, developing countries, probabilistic modelling*

### Article Highlights

- Models adoption probability at depot level, nested within regional zones.
- Quantifies zone-level variability with precise random effects estimates.
- Provides granular, evidence-based assessment beyond national averages.
- Offers a rigorous tool for engineers and policymakers in developing contexts.

### Core Model Specification

$\text{logit}(p_{ij}) = \alpha + \beta X_{ij} + u_j$ , where  $u_j \sim N(0, \sigma^2_u)$  represents zone-level random effects, enabling analysis of multi-level variability.

*This framework provides a statistically robust alternative to simplistic aggregated metrics.*

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