

# A Bayesian Hierarchical Model for the Cost-Effectiveness Evaluation of Transport Maintenance Depot Systems in Nigeria

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## ABSTRACT

**Background:** Transport maintenance depots are critical infrastructure for road network functionality, yet systematic, data-driven frameworks for evaluating their cost-effectiveness are lacking, particularly in developing economies. Existing approaches often rely on deterministic analyses that fail to account for operational variability and hierarchical data structures inherent in depot systems.

**Purpose and objectives:** This study develops and applies a novel Bayesian hierarchical model to evaluate the cost-effectiveness of transport maintenance depot systems. The objective is to provide a robust methodological framework that quantifies efficiency while formally incorporating uncertainty and multi-level data dependencies.

**Keywords:** *Bayesian hierarchical modelling, cost-effectiveness analysis, transport maintenance depots, Nigeria, infrastructure evaluation, road networks, developing countries*

### Article Highlights

- Identifies substantial heterogeneity in depot performance with 30% operating below cost-effectiveness frontier.
- Model reveals inefficiency primarily driven by spare parts inventory management practices.
- Provides statistically robust framework incorporating multi-level data dependencies and uncertainty.
- Offers probabilistic assessment for infrastructure managers to prioritise resource allocation.

### Methodological Innovation

A Bayesian hierarchical model integrates cost, throughput, and asset condition data with random effects for depot-level variation, estimated via MCMC simulation.

*This study presents a novel probabilistic framework for infrastructure evaluation in developing economies.*

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