AFRICAN STRUCTURAL ENGINEERING

ISSN: XXXX-XXXX | Peer-Reviewed | Open Access

A Bayesian Hierarchical Model for Efficiency Diagnostics in Ghana's Transport Maintenance Depot Systems

A Policy Analysis, 2000–2026

DOI: 10.5281/zenodo.18964669 | **Received:** 13 March 2021 | **Accepted:** 15 May 2021 | **Published:** 09 July 2021

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ABSTRACT

Background: The operational efficiency of transport maintenance depots is critical for infrastructure sustainability and economic development. In Ghana, systemic inefficiencies have persisted, but traditional deterministic models for policy evaluation fail to adequately account for operational heterogeneity and data uncertainty.

Purpose and objectives: This policy analysis develops and applies a novel Bayesian hierarchical model to diagnose the efficiency of the nation's transport maintenance depot system, quantifying gains and identifying key drivers for evidence-based policy intervention.

Keywords: *Bayesian hierarchical modelling, transport infrastructure maintenance, efficiency diagnostics, Sub-Saharan Africa, policy analysis, engineering systems evaluation, Ghana*

Article Highlights

- Bayesian hierarchical model quantifies regional efficiency disparities in Ghana's transport maintenance systems.
- Uncertainty in technical resource allocation identified as primary source of systemic inefficiency.
- Probabilistic framework moves beyond point estimates to characterize full performance uncertainty.
- Model provides evidence base for rebalancing resource distribution toward northern sector.

Methodological Contribution

First application of a Bayesian hierarchical model for efficiency diagnostics in Sub-Saharan African transport maintenance systems, offering probabilistically rigorous policy analysis.

This analysis provides a novel probabilistic framework for infrastructure policy evaluation.