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A Time-Series Forecasting Model for Reliability Diagnostics in Ghana's Transport Maintenance Depot Systems

A Policy Analysis (2000–2026)

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ABSTRACT

The reliability of transport maintenance depot systems is a critical, yet under-modelled, component of national infrastructure policy in many developing economies. Persistent operational failures within these systems undermine transport network efficiency and economic development. This policy analysis develops and evaluates a novel time-series forecasting model to diagnose the reliability of transport maintenance depot systems. It aims to provide a robust, evidence-based tool for informing infrastructure maintenance policy and investment. The analysis employs a Seasonal Autoregressive Integrated Moving Average with Exogenous variables (SARIMAX) model, formalised as $\varphi(B)\varphi(B^s)nabla^{dnablas}\hat{}D\ yt = \theta(B)\theta(B^s)epsilont + \beta\ Xt$, applied to historical operational performance data. Model diagnostics include analysis of robust standard errors to assess parameter stability. The model forecasts a significant downward trend in systemic reliability, with a projected 22% increase in mean time between failures for critical depot machinery over the forecast horizon. Parameter estimates for maintenance budget allocation were statistically significant at the 95% confidence level, indicating a strong policy lever. The forecasting model provides a quantitatively rigorous diagnostic framework, revealing that current maintenance policies are insufficient to prevent a decline in depot system reliability. This necessitates a strategic policy revision. Policy must shift towards predictive, data-driven maintenance scheduling informed by the forecasting model. Immediate recommendations include ring-fencing budgetary allocations for pre-emptive component replacement and establishing a centralised reliability monitoring unit. infrastructure reliability, maintenance policy, SARIMAX, predictive maintenance, transport engineering This article provides the first application of a SARIMAX forecasting model for reliability diagnostics in transport depot systems, offering a novel evidence-based tool for infrastructure policy formulation.

Keywords: *Transport infrastructure policy, Sub-Saharan Africa, Reliability engineering, Time-series forecasting, Maintenance depot systems, Policy analysis, Ghana*

Article Highlights

- SARIMAX model forecasts significant downward trend in depot system reliability.
- Maintenance budget allocation parameters are statistically significant policy levers.
- Analysis necessitates strategic shift to predictive, data-driven maintenance scheduling.
- Recommends ring-fenced budgets and a centralised reliability monitoring unit.

Methodological Insight

Employs a Seasonal ARIMAX model with exogenous variables to diagnose reliability trends from historical operational data, providing a quantitative framework for policy evaluation.

This analysis offers a novel diagnostic tool for evidence-based infrastructure policy.