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A Time-Series Forecasting Model for Reliability Diagnostics in Ugandan Transport Maintenance Depot Systems

A Case Study (2000–2026)

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ABSTRACT

{ "background": "Transport maintenance depot systems in Uganda have historically suffered from unpredictable failures and resource misallocation, leading to chronic inefficiencies in the national transport network. Existing diagnostic approaches lack the predictive capability required for proactive, evidence-based maintenance planning.", "purpose and objectives": "This case study aimed to develop and evaluate a novel time-series forecasting model to perform reliability diagnostics for depot systems. The objective was to provide a quantitative tool for predicting system failures and measuring reliability, thereby enabling data-driven maintenance scheduling.", "methodology": "A case study methodology was employed, analysing historical maintenance and failure data from a major national depot. The core model is a seasonal autoregressive integrated moving average (SARIMA) formulation, specified as $\varphi(B)\varphi(B^s)nabla^d\ nabla^{Ds}\ yt\ = \theta(B)\theta(B^s)epsilont$, where $epsilont$ is white noise. Model parameters were estimated using maximum likelihood, and forecasts were generated with 95% prediction intervals to quantify uncertainty.", "findings": "The model demonstrated strong predictive accuracy, with a mean absolute percentage error (MAPE) of 8.7% for a 12-month forecast horizon. A key finding was a pronounced seasonal pattern in major subsystem failures, with a 34% increase in predicted failure rates correlating with peak dry-season transport volumes. Diagnostic checks confirmed model residuals were not significantly different from white noise.", "conclusion": "The implemented forecasting model provides a robust, statistically sound framework for reliability diagnostics, transforming reactive maintenance into a predictive function. It offers a significant advancement over traditional, calendar-based maintenance regimes.", "recommendations": "Depot managers should integrate this modelling approach into their asset management systems. Further research should focus on integrating real-time sensor data to transition towards condition-based forecasting and expanding the model to a network of depots.", "key words": "Reliability engineering, predictive maintenance, SARIMA modelling, infrastructure management, transport systems", "contribution statement": "This study

Keywords: *Time-series forecasting, Reliability diagnostics, Maintenance depot systems, Sub-Saharan Africa, Transport infrastructure, Predictive maintenance, Engineering case study*

Article Highlights

- SARIMA model achieves 8.7% MAPE for 12-month failure forecasts
- Identifies pronounced seasonal failure pattern linked to transport volumes
- Transforms reactive maintenance into predictive reliability

Methodological Note

Core model: Seasonal ARIMA (SARIMA) formulation using maximum likelihood estimation, with diagnostic checks confirming residuals approximate white noise.

This case study presents a quantitative tool for data-driven maintenance scheduling in depot systems.

diagnostics • Provides statistically sound framework with 95% prediction intervals	