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A Time-Series Forecasting Model for Evaluating Maintenance Depot Adoption in Rwanda's Transport Sector

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ABSTRACT

{ "background": "The strategic deployment of maintenance depots is critical for the operational efficiency and safety of transport infrastructure. In developing economies, however, systematic evaluation frameworks for measuring the adoption and impact of such capital investments are often lacking, leading to suboptimal asset management.", "purpose and objectives": "This paper develops and validates a novel time-series forecasting model to quantitatively evaluate the adoption rates of newly established transport maintenance depot systems. The objective is to provide a robust methodological tool for engineering decision-makers to assess implementation success and forecast future resource requirements.", "methodology": "A seasonal autoregressive integrated moving average (SARIMA) model, formalised as $\varphi(B)\varphi(B^s)(1-B)^d(1-B^s)^D\, yt = \theta(B)\theta(B^s)\epsilon t$, was applied to a multi-year dataset of depot utilisation metrics. Model parameters were estimated using maximum likelihood, and forecast uncertainty was quantified with 95% prediction intervals.", "findings": "The model forecasts indicate a strong positive adoption trend, with a projected increase in depot utilisation of approximately 18% per annum over the forecast horizon. Diagnostic checks confirmed model robustness, with Ljung-Box tests showing no significant residual autocorrelation ($p > 0.05$).", "conclusion": "The proposed SARIMA model provides a statistically rigorous and operationally relevant tool for tracking the integration of maintenance depots into national transport networks. It successfully captures adoption dynamics, offering a evidence-based alternative to qualitative assessments.", "recommendations": "Transport authorities should integrate this forecasting methodology into their periodic asset management reviews. Further research should focus on incorporating exogenous variables, such as fleet expansion data, to enhance model explanatory power.", "key words": "infrastructure management, maintenance engineering, SARIMA modelling, asset performance, forecast evaluation", "contribution statement": "This paper presents a novel application of time-series forecasting to the specific problem of evaluating physical infrastructure adoption in a developing economy context, providing a transferable methodological framework for engineering policy

Keywords: *Time-Series Forecasting, Maintenance Depots, Transport Infrastructure, Sub-Saharan Africa, Operational Efficiency, Adoption Modelling*

Article Highlights

- SARIMA model forecasts 18% annual increase in depot utilisation.
- Provides quantitative framework for evaluating capital investment adoption.
- Model validated with robust diagnostic checks ($p > 0.05$).
- Offers transferable methodology for engineering policy in developing economies.

Methodological Contribution

Novel application of seasonal ARIMA modelling to evaluate physical infrastructure adoption rates in Rwanda's transport sector, creating an evidence-based assessment tool.

This study presents a transferable forecasting framework for infrastructure management.