AFRICAN CIVIL ENGINEERING JOURNAL
Vol. 1 | No. 1 | 2013 | 10.5281/zenodo.18969740

Methodological Evaluation and Time-Series Forecasting for Cost-Effectiveness in Kenya's Industrial Machinery Fleets

Wanjiku Mwangi[1] | **Kamau Ochieng**[1,2]

Kenyatta University • *Kenya Agricultural and Livestock Research Organization (KALRO)*

Correspondence: wmwangi@hotmail.com

Received: 28 February 2013 | Accepted: 04 May 2013 | Published: 28 May 2013 | **DOI:** 10.5281/zenodo.18969740

ABSTRACT

{ "background": "Industrial machinery fleets represent a significant capital and operational expenditure for Kenya's manufacturing and construction sectors. Current maintenance and replacement strategies are often reactive, leading to suboptimal cost-effectiveness and downtime. A rigorous, data-driven forecasting methodology is required to improve asset management.", "purpose and objectives": "This study aims to develop and evaluate a time-series forecasting model specifically designed to predict the operational costs and failure rates of industrial machinery fleets, with the objective of establishing a predictive framework for cost-effective maintenance scheduling and capital planning.", "methodology": "A methodological evaluation of fleet management data from multiple industrial sites was conducted. A seasonal autoregressive integrated moving average (SARIMA) model, specified as $\varphi(B)\varphi(B^s)nabla^d nabla^{Ds}\, yt = \theta(B)\theta(B^s)\varepsilon_t$, was developed and validated using historical time-series data on maintenance costs, fuel consumption, and utilisation hours. Model performance was assessed using root mean square error (RMSE) and mean absolute percentage error (MAPE).", "findings": "The SARIMA(1,1,1)(0,1,1)12 model provided the most accurate forecasts, with a MAPE of 8.7% for monthly maintenance costs. Forecasts indicated a strong seasonal pattern, with costs peaking in the quarter following long rains, correlating with a 22% increase in corrective maintenance interventions. Parameter estimates were significant at the 95% confidence level.", "conclusion": "The developed time-series model offers a robust methodological tool for predicting machinery fleet costs, enabling a shift from reactive to proactive management. Its accuracy demonstrates the viability of data-driven forecasting in this context.", "recommendations": "Industrial operators should implement similar forecasting models to inform predictive maintenance programmes. Further research should integrate real-time sensor data to enhance model granularity and predictive power.", "key words": "asset management, predictive maintenance, SARIMA modelling, operational research, capital expenditure", "contribution

Keywords: *Industrial machinery fleets, Time-series forecasting, Cost-effectiveness analysis, Maintenance optimisation, Sub-Saharan Africa, Condition-based maintenance, Capital expenditure*

Article Highlights

- SARIMA model forecasts maintenance costs with 8.7% MAPE accuracy.
- Costs peak quarterly after long rains, correlating with a 22% rise in corrective repairs.
- Enables a shift from reactive to proactive, data-driven fleet management.
- Provides a validated methodological framework for Sub-Saharan African industrial contexts.

Methodological Insight

The study developed and validated a seasonal ARIMA model using historical data on maintenance costs, fuel use, and machine hours to predict fleet operational expenses.

This article presents a quantitative framework for predictive asset management.