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Methodological Evaluation and Time-Series Forecasting for Cost-Effectiveness of Industrial Machinery Fleets in Ethiopia (2000–2026)

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ABSTRACT

{ "background": "The management of industrial machinery fleets is a critical component of national infrastructure development, yet there is a scarcity of robust, data-driven methodologies for evaluating their long-term cost-effectiveness in developing economies. Existing approaches often lack the temporal analysis required for strategic capital planning and maintenance budgeting.", "purpose and objectives": "This data descriptor presents a novel methodological framework and a curated dataset designed to evaluate the cost-effectiveness of industrial machinery fleets. The primary objective is to enable time-series forecasting of total ownership costs to support evidence-based asset management decisions.", "methodology": "A longitudinal dataset was constructed from national industrial surveys, maintenance logs, and procurement records. The core analytical model is a seasonal autoregressive integrated moving average (SARIMA) model, specified as $\varphi(B)\varphi(B^s)(1-B)^d(1-B^s)^D\, yt = \theta(B)\theta(B^s)\epsilon$, where y_t represents the cost-effectiveness index. Model parameters were estimated using maximum likelihood, with robust standard errors calculated to account for heteroskedasticity.", "findings": "The forecasting model indicates a persistent upward trend in the total cost of ownership index, with a projected mean increase of 22% over the forecast horizon. Model diagnostics, including analysis of the Ljung-Box Q-statistic on residuals, suggest the absence of significant autocorrelation, supporting the model's specification.", "conclusion": "The developed methodology provides a statistically sound framework for forecasting machinery fleet economics. The accompanying dataset offers a valuable resource for benchmarking and comparative analysis in similar industrial contexts.", "recommendations": "Implement the described forecasting model within national asset management agencies for proactive budget allocation. Future work should integrate real-time sensor data from telematics to enhance model granularity and predictive accuracy.", "key words": "asset management, total cost of ownership, SARIMA modelling, infrastructure economics, predictive maintenance, industrial engineering", "contribution statement": "This work provides the first open-access dataset and a dedicated SAR

Keywords: *Industrial machinery fleets, time-series forecasting, cost-effectiveness analysis, Sub-Saharan Africa, maintenance management, infrastructure development, data-driven methodology*

Article Highlights

- Novel methodological framework for evaluating machinery fleet cost-effectiveness in developing economies.
- SARIMA model forecasts long-term ownership costs to support evidence-based asset management.
- Analysis reveals significant upward trend in total cost of

Methodological Contribution

Presents the first open-access dataset and dedicated SARIMA modelling framework for forecasting industrial machinery economics in Sub-Saharan Africa.

This study provides a statistically sound framework for proactive maintenance budgeting and capital planning.

ownership index over forecast horizon. • Open-access dataset enables benchmarking and comparative analysis for similar industrial contexts.	