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SHORT REPORT

Methodological Evaluation and Time-Series Forecasting for Cost-Effectiveness in South African Manufacturing Plant Systems

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ABSTRACT

{ "background": "Optimising cost-effectiveness in manufacturing plant systems is a persistent challenge for industrial engineering, particularly in contexts with volatile operational and economic conditions. Existing forecasting methods often lack the adaptability required for such dynamic environments.", "purpose and objectives": "This short report aims to methodologically evaluate time-series forecasting techniques for measuring and predicting cost-effectiveness in plant systems. The objective is to propose and validate a robust model suitable for application within the local industrial sector.", "methodology": "A comparative evaluation of autoregressive integrated moving average (ARIMA) and seasonal ARIMA (SARIMA) models was conducted using historical operational cost data from three discrete manufacturing facilities. The core forecasting model is defined as $\varphi(B)\nabla^d y_t = \theta(B)\varepsilon_t$, where ∇^d denotes the differencing operator. Model selection was based on the Akaike Information Criterion, with robust standard errors calculated to account for heteroscedasticity.", "findings": "The SARIMA$(1,1,1)(0,1,1)_7$ model demonstrated superior forecasting performance, reducing mean absolute percentage error (MAPE) by approximately 18% compared to the best non-seasonal ARIMA specification. Forecasts for key cost drivers showed a 95% prediction interval width that was 22% narrower, indicating greater precision.", "conclusion": "The methodological evaluation confirms that explicitly modelling seasonal patterns significantly enhances forecast accuracy for manufacturing cost streams. This provides a more reliable basis for cost-effectiveness analysis and proactive management.", "recommendations": "Practitioners should integrate seasonal decomposition routines into their forecasting workflows. Further research should test the model's generalisability across other industrial sectors and incorporate exogenous economic variables.", "key words": "cost-effectiveness, time-series forecasting, manufacturing systems, industrial engineering, ARIMA models", "contribution statement": "This report provides a novel, validated methodological framework for cost forecasting tailored to the operational rhythms of local manufacturing plants, directly contributing to improved budgetary control and resource

Keywords: *manufacturing systems optimisation, time-series forecasting, cost-effectiveness analysis, industrial engineering, South African manufacturing, operational research*

Article Highlights

Core Forecasting Model

• SARIMA(1,1,1)(0,1,1)$_7$ model showed 18% lower MAPE than best non-seasonal ARIMA. • 95% prediction interval width was 22% narrower, indicating greater forecast precision. • Methodological framework validates seasonal decomposition for manufacturing cost streams. • Provides reliable basis for cost-effectiveness analysis and proactive management.	The analysis employs $\phi(B)\nabla^d yt = \theta(B)\epsilont$, where ∇^d denotes the differencing operator. Model selection was based on Akaike Information Criterion with robust standard errors. *This report provides a validated methodological framework for cost forecasting in local manufacturing contexts.*