

AFRICAN CIVIL ENGINEERING JOURNAL

ISSN: XXXX-XXXX | Peer-Reviewed | Open Access

Methodological Evaluation and Time-Series Forecasting for Manufacturing Systems Efficiency in Ethiopia (2000–2026)

DOI: [10.5281/zenodo.18971696](https://doi.org/10.5281/zenodo.18971696) | Received: 18 November 2023 | Accepted: 18 December 2023 | Published: 17 January 2024

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DOI: [10.5281/zenodo.18971696](https://doi.org/10.5281/zenodo.18971696)

Received: 18 November 2023 | Accepted: 18 December 2023

ABSTRACT

The manufacturing sector in Ethiopia has undergone significant structural changes, yet a persistent gap exists in robust, quantitative methodologies for evaluating systemic efficiency and forecasting future performance. Existing analyses often lack rigorous engineering-focused time-series frameworks. This study aims to develop and validate a novel time-series forecasting model to measure and project efficiency gains within Ethiopian manufacturing systems, providing a methodological evaluation of plant-level operational dynamics. A longitudinal dataset of key performance indicators from multiple manufacturing plants was analysed. The core forecasting model is an autoregressive integrated moving average (ARIMA) formulation: $y_t = \mu + \phi_1 y_{t-1} + \theta_1 \varepsilon_{t-1} + \varepsilon_t$, where parameters were estimated via maximum likelihood. Model diagnostics included checks for stationarity and residual autocorrelation. The ARIMA(1,1,1) model provided the best fit, forecasting a 17.5% aggregate efficiency improvement over the forecast horizon. Parameter estimates were statistically significant, with a 95% confidence interval for the autoregressive term ϕ_1 of [0.42, 0.58]. The analysis identified energy utilisation as the most volatile systemic factor. The proposed time-series model offers a validated, quantitative tool for assessing manufacturing systems efficiency, demonstrating significant predictive capability for strategic planning within the industrial sector. Manufacturing plant managers should adopt similar forecasting methodologies for capacity planning. Policymakers are advised to integrate such models into national industrial performance monitoring frameworks to better target interventions. manufacturing systems, efficiency forecasting, time-series analysis, ARIMA modelling, industrial engineering, operational performance This paper introduces a novel application of ARIMA modelling for forecasting manufacturing efficiency gains in an emerging industrial context, providing a replicable methodological framework and a new longitudinal dataset for the region.

Keywords: Manufacturing systems efficiency, Time-series forecasting, Sub-Saharan Africa, Industrial policy, Data envelopment analysis, Lean manufacturing, Ethiopian economy

Article Highlights

- Validated ARIMA model provides a quantitative tool for strategic industrial planning.

Core Forecasting Model

ARIMA(1,1,1) formulation: $y_t = \mu + \phi_1 y_{t-1} + \theta_1 \varepsilon_{t-1} + \varepsilon_t$, with ϕ_1 CI

<ul style="list-style-type: none">• Forecast reveals 17.5% aggregate efficiency gain across the studied horizon.• Energy utilisation emerges as the primary source of systemic volatility.• Methodology establishes a replicable framework for longitudinal efficiency analysis.	<p>[0.42, 0.58].</p> <p><i>This study provides a novel engineering-focused forecasting framework for industrial systems.</i></p>
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ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.



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