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SHORT REPORT

Methodological Evaluation and Multilevel Regression Analysis of Manufacturing Plant Systems for Efficiency Gains in Kenya

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ABSTRACT

Background: The manufacturing sector is a critical component of Kenya's economic development strategy, yet systematic, data-driven methodologies for evaluating plant-wide operational efficiency remain underutilised. Current assessments often lack the statistical rigour to disentangle system-level from unit-level performance drivers.

Purpose and objectives: This short report aims to methodologically evaluate manufacturing plant systems and quantify efficiency gains using a multilevel modelling framework. The objective is to provide a replicable analytical approach for identifying significant levers for productivity improvement within the local industrial context.

Keywords: *Manufacturing systems, Operational efficiency, Multilevel modelling, Sub-Saharan Africa, Lean production, Industrial development, Regression analysis*

Article Highlights

- Multilevel modelling isolates hierarchical efficiency drivers in manufacturing systems.
- Predictive maintenance adoption shows significant positive association with throughput (β=0.31).
- Intra-class correlation of 0.18 confirms notable plant-level clustering effects.
- Provides replicable analytical framework for Sub-Saharan African industrial contexts.

Core Analytical Framework

Two-level hierarchical linear model with production lines nested within plants: $Y_{ij} = \beta_{0j} + \beta_{1}X_{1ij} + e_{ij}$, where $\beta_{0j} = \gamma_{00} + \gamma_{01}Z_j + u_{0j}$.

This report presents a methodological framework for disentangling system-level from unit-level performance drivers.