

# Methodological Evaluation and Time-Series Forecasting for Cost-Effectiveness of Process-Control Systems in Uganda

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## ABSTRACT

**Background:** Process-control systems are increasingly adopted in industrial and infrastructure projects in developing economies, yet robust methodologies for evaluating their long-term cost-effectiveness are lacking. Existing assessments often rely on static cost-benefit analyses, failing to account for dynamic operational variables and temporal performance degradation.

**Purpose and objectives:** This study aims to develop and validate a time-series forecasting model to quantitatively measure the cost-effectiveness of process-control systems. The objective is to provide a methodological framework that integrates operational performance data with lifecycle cost projections.

**Keywords:** *Process-control systems, Cost-effectiveness analysis, Time-series forecasting, Sub-Saharan Africa, Industrial automation, Developing economies, Engineering project evaluation*

### Article Highlights

- Develops an ARIMAX time-series model to forecast cost-effectiveness of process-control systems.
- Model demonstrates superior predictive accuracy over static benchmark evaluations.
- Quantifies the impact of operational variables, like calibration frequency, on long-term financial performance.
- Provides a dynamic methodological framework for capital investment appraisal in developing economies.

### Core Forecasting Model

The study employs an ARIMAX(1,1,1) model, specified as  $\Delta y_t = \alpha + \sum \varphi_i \Delta y_{t-i} + \sum \theta_i \varepsilon_{t-i} + \sum \beta_i X_{t-i} + \varepsilon_t$ , where  $y_t$  is the cost-effectiveness ratio and  $X_t$  captures exogenous operational shocks.

*This article presents a novel quantitative framework for evaluating industrial automation investments.*

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