

# A Multilevel Regression Analysis of Process-Control System Efficiency Gains in Ghanaian Industrial Operations

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## ABSTRACT

**Background:** The adoption of automated process-control systems in industrial operations is a key driver of productivity. However, rigorous, quantitative evaluations of their efficiency gains within specific regional contexts, particularly in West Africa, are scarce in the engineering literature.

**Purpose and objectives:** This study aims to quantify the operational efficiency gains attributable to modern process-control systems within Ghana's manufacturing and processing sectors. It seeks to identify the key system characteristics and contextual factors that moderate these gains.

**Keywords:** *Process-control systems, Industrial efficiency, Multilevel modelling, Sub-Saharan Africa, Regression analysis, Automation, Productivity measurement*

### Article Highlights

- Multilevel regression isolates firm- and process-level efficiency drivers.
- Integrated systems show 17.3% mean efficiency gain over legacy controls.
- Human capital investment is a critical moderating factor for ROI.
- Provides a novel quantitative framework for Sub-Saharan African industry.

### Methodological Note

The analysis employs a multilevel model to account for processes nested within firms, using robust standard errors for inference on a unique cross-sectional dataset from Ghana.

*This study offers a rigorous, context-specific evaluation of automation's impact.*

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