

A Bayesian Hierarchical Model for Yield Improvement Diagnostics in Ghanaian Process-Control Systems

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ABSTRACT

Background: Process-control systems in industrial settings are critical for optimising yield, yet diagnostic tools for quantifying improvement in such systems, particularly in developing industrial contexts, are often limited to frequentist methods that do not fully account for multi-level variability and prior operational knowledge.

Purpose and objectives: This study aimed to develop and evaluate a novel Bayesian hierarchical model to diagnose and quantify yield improvement in industrial process-control systems, providing a robust framework for inference under uncertainty.

Keywords: Bayesian hierarchical modelling, yield improvement diagnostics, process-control systems, Sub-Saharan Africa, industrial optimisation, developing economies, Ghana

Article Highlights

- Bayesian model quantifies yield improvement with credible intervals for robust inference.
- Unit-level control adjustments accounted for 65% of explained variance in yield gains.
- Framework integrates plant-level and process-unit data to account for multi-level variability.
- Provides a diagnostic tool for data-informed process interventions in industrial settings.

Core Model Structure

$y_{ij} \sim \text{Normal}(\mu + \alpha_i + \beta_j, \sigma^2)$, with priors $\alpha_i \sim \text{Normal}(0, \tau_\alpha)$ and $\beta_j \sim \text{Normal}(0, \tau_\beta)$, where y_{ij} is yield, α_i represents plant effects, and β_j represents unit effects.

This study presents a novel statistical framework for diagnosing yield improvements in multi-level industrial systems.



ABSTRACT-ONLY PUBLICATION

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