

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

A Methodological Evaluation Dataset

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ABSTRACT

Background: Process-control systems in manufacturing are critical for operational efficiency and yield optimisation. In many developing industrial contexts, such as those in East Africa, diagnostic tools for yield improvement are often limited by sparse, heterogeneous data and the need to quantify uncertainty in system performance.

Purpose and objectives: This Data Descriptor presents a methodological evaluation dataset constructed to assess a novel Bayesian hierarchical model for diagnosing yield improvements in industrial process-control systems. The objective is to provide a reusable, structured dataset that enables the validation of the proposed model's capacity to isolate process-level effects from plant-level variability.

Keywords: *Bayesian hierarchical modelling, yield improvement diagnostics, process-control systems, Sub-Saharan Africa, manufacturing data, engineering methodology, industrial diagnostics*

Article Highlights

- Dataset enables validation of model's capacity to isolate process-level effects from plant-level variability.
- 90% HPD interval for global intervention coefficient [0.15, 0.42] confirms inferential capability.
- Synthetic data reflects realistic operational parameters from multiple manufacturing plants.
- Method provides probabilistic insights into yield drivers in complex industrial settings.

Core Statistical Model

$y_{ij} \sim \text{Normal}(\alpha_j + \beta_j x_{ij}, \sigma_y)$ with $\alpha_j \sim \text{Normal}(\mu_\alpha, \sigma_\alpha)$ and $\beta_j \sim \text{Normal}(\mu_\beta, \sigma_\beta)$, where i indexes observations and j indexes plants.

This Data Descriptor presents a methodological evaluation dataset for diagnostic model validation.

ABSTRACT-ONLY PUBLICATION

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