

# A Bayesian Hierarchical Modelling Framework for Yield Improvement Diagnostics in Ugandan Manufacturing Systems

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## ABSTRACT

**Background:** Manufacturing systems in Uganda face persistent challenges in achieving consistent product yield, with diagnostic efforts often hampered by fragmented data and complex, multi-level process interactions. Existing analytical methods frequently lack the flexibility to model plant-specific variability while enabling inference across a sector.

**Purpose and objectives:** This article presents a novel Bayesian hierarchical modelling framework designed to diagnose and quantify the drivers of yield improvement in such contexts. Its objective is to provide a robust, unified methodology for separating systemic effects from plant-specific operational factors.

**Keywords:** Bayesian hierarchical modelling, yield improvement, manufacturing systems, Sub-Saharan Africa, process diagnostics, uncertainty quantification, industrial engineering

### Article Highlights

- A Bayesian hierarchical model separates systemic effects from plant-specific operational factors.
- Application demonstrates precise estimation of posterior probability intervals for key parameters.
- Framework integrates disparate data sources to isolate influential factors at appropriate hierarchical levels.
- Provides statistically rigorous and operationally actionable diagnostics for complex manufacturing environments.

### Methodological Contribution

Introduces a novel, generalisable Bayesian hierarchical modelling framework that formally incorporates multi-level uncertainty for manufacturing diagnostics in data-fragmented contexts.

*Presents a statistically robust framework for diagnosing yield drivers in complex, multi-plant manufacturing systems.*

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