

A Bayesian Hierarchical Modelling Framework for Yield Improvement Diagnostics in Tanzanian Industrial Machinery Fleets

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Received: 29 October 2007 | Accepted: 12 February 2008 | Published: 03 April 2008 | DOI:

[10.5281/zenodo.18972346](https://doi.org/10.5281/zenodo.18972346)

ABSTRACT

Background: Industrial machinery fleets in developing economies often operate with suboptimal yields due to complex, interacting factors. Current diagnostic approaches in structural engineering and maintenance management frequently lack a formal mechanism to quantify uncertainty and integrate multi-level operational data, hindering targeted improvement strategies.

Purpose and objectives: This article presents a novel Bayesian hierarchical modelling framework designed to diagnose and quantify the drivers of yield improvement in industrial machinery. The objective is to provide a robust methodological tool for decomposing variance across machine, site, and operational levels to identify priority intervention points.

Keywords: *Bayesian hierarchical modelling, yield improvement diagnostics, industrial machinery fleets, Sub-Saharan Africa, structural engineering methodology, reliability analysis, developing economies*

Article Highlights

- A three-level hierarchical model decomposes variance across machine, site, and operational levels.
- The framework quantifies diagnostic uncertainty through full posterior distributions.
- Methodology enables data-driven decision-making for structural and operational improvements.
- Moves maintenance engineering beyond average-based diagnostics to probabilistic inference.

Methodological Contribution

Presents a novel Bayesian hierarchical model that formally integrates multi-level operational data to diagnose yield drivers in industrial machinery fleets, explicitly quantifying uncertainty at each level.

This article provides a statistically rigorous diagnostic tool for maintenance engineers and industrial managers.

ABSTRACT-ONLY PUBLICATION

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