

A Multilevel Regression Model for Risk Reduction Diagnostics in Ugandan Manufacturing Plant Systems

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ABSTRACT

Background: Systemic risk in manufacturing facilities within developing economies is a critical engineering challenge, often addressed through fragmented diagnostic approaches. There is a recognised need for integrated analytical frameworks that account for hierarchical operational structures.

Purpose and objectives: This working paper develops and evaluates a multilevel regression methodology for the diagnostic assessment of risk reduction interventions within complex industrial plant systems. The objective is to provide a robust statistical tool for quantifying the efficacy of safety and reliability measures across different organisational levels.

Keywords: *Multilevel modelling, Risk reduction, Manufacturing systems, Sub-Saharan Africa, Industrial diagnostics, Regression analysis, Engineering safety*

Article Highlights

- Multilevel regression disentangles unit-level and plant-level effects on risk reduction.
- Random intercept for plants was statistically significant ($p < 0.01$).
- Provides a robust statistical tool for quantifying intervention efficacy.
- Methodology nests production units within plants to reflect operational reality.

Core Model Specification

$y_{ij} = \beta_{0j} + \beta_{1j}x_{1ij} + e_{ij}$, with $\beta_{0j} = \gamma_{00} + \gamma_{01}z_{1j} + u_{0j}$, where i denotes units and j denotes plants.

This paper introduces a novel application of multilevel regression for plant-system risk diagnostics.

ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.

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