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Methodological Evaluation and Risk Reduction in Senegalese Manufacturing Systems

A Multilevel Regression Analysis

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ABSTRACT

Background: Manufacturing systems in developing economies face unique operational and infrastructural challenges that elevate systemic risk. A rigorous methodological framework for quantifying and mitigating these risks within the West African context is notably absent in the engineering literature.

Purpose and objectives: This study aims to develop and apply a multilevel regression methodology to evaluate systemic performance and quantify risk reduction in manufacturing plants. The primary objective is to identify the most influential operational and organisational factors affecting production reliability.

Keywords: *Manufacturing systems, Multilevel regression, Risk reduction, Sub-Saharan Africa, Operational challenges*

Article Highlights

- A two-level hierarchical linear model quantifies risk in manufacturing systems.
- Integrated maintenance protocols show a strong protective effect ($\beta = 0.45$).
- Risk is hierarchically structured, with mid-level factors being most influential.
- The methodology addresses a gap in frameworks for West African contexts.

Core Methodological Contribution

Applies a multilevel regression model to decompose and quantify systemic risk within Senegalese manufacturing, offering a replicable framework for similar developing economies.

This analysis provides evidence-based guidance for operational improvements in Sub-Saharan African manufacturing.