

# 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.*

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