

Methodological Evaluation and Panel-Data Estimation for Manufacturing Systems Risk Reduction in Ethiopia (2000–2026)

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ABSTRACT

Background: Manufacturing systems in developing economies face significant operational and safety risks, yet there is a paucity of longitudinal, plant-level studies quantifying risk reduction strategies within these contexts. Existing methodological approaches often lack the rigour to isolate causal factors from panel data.

Purpose and objectives: This study aims to methodologically evaluate risk assessment frameworks and develop a robust panel-data model to estimate the efficacy of systemic interventions in reducing critical failures within manufacturing plants.

Keywords: *Manufacturing systems, Risk reduction, Panel-data estimation, Sub-Saharan Africa, Operational safety, Developing economies, Longitudinal study*

Article Highlights

- Novel unbalanced panel dataset constructed from repeated plant surveys and operational records.
- Fixed-effects model isolates causal impact from unobserved plant heterogeneity.
- Integrated process safety management shows statistically significant risk reduction.
- Methodological framework enables credible causal inference for engineering policy.

Core Methodology

Fixed-effects regression on an unbalanced panel, with cluster-robust inference, models the logged incident rate against time-varying intervention variables.

This study offers a rigorous econometric framework for evaluating manufacturing safety interventions in developing economies.

ABSTRACT-ONLY PUBLICATION

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