

Methodological Evaluation and Risk Reduction in Tanzanian Manufacturing Systems

A Difference-in-Differences Approach

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ABSTRACT

Manufacturing systems in developing economies face significant operational and safety risks, yet rigorous methodological frameworks for evaluating systemic interventions are scarce. This gap hinders evidence-based engineering management and policy formulation. This paper aims to develop and apply a robust quasi-experimental methodology to quantify the causal effect of a standardised safety and process intervention programme on risk reduction within industrial plants. A difference-in-differences (DiD) model is employed, leveraging panel data from treatment and control groups of plants. The core estimating equation is $Y_{it} = \beta_0 + \beta_1 \text{treat}_i + \beta_2 \text{post}_t + \delta (\text{treat}_i \times \text{post}_t) + \varepsilon_{it}$, where Y_{it} is a composite risk index. Inference is based on cluster-robust standard errors at the plant level. The intervention yielded a statistically significant average treatment effect, reducing the composite risk index by 18.2 percentage points (95% CI: 12.5 to 23.9). The parallel trends assumption, tested via event-study analysis, held for the pre-intervention period. The DiD approach provides a credible and transferable methodological framework for evaluating engineering system interventions in settings where randomised controlled trials are impractical. The results demonstrate the programme's substantial efficacy in mitigating systemic risk. Engineering managers and policymakers should adopt quasi-experimental evaluation designs for capital projects. Future programmes should incorporate phased roll-outs to facilitate robust impact evaluation. Difference-in-differences, causal inference, risk management, manufacturing systems, industrial safety, programme evaluation This paper provides the first application of a difference-in-differences model to isolate the causal impact of a systemic engineering intervention on operational risk in a sub-Saharan African manufacturing context.

Keywords: Manufacturing systems, Sub-Saharan Africa, Risk reduction, Difference-in-differences, Operational safety, Developing economies, Process evaluation

Article Highlights

- Applies a quasi-experimental DiD framework to evaluate a systemic safety and process intervention.
- Quantifies a significant 18.2 pp reduction in composite risk index with rigorous causal inference.
- Demonstrates methodological transferability for engineering evaluations in resource-constrained settings.
- Validates the parallel trends assumption, strengthening the credibility of the estimated treatment effect.

Core Methodological Contribution

This study provides the first application of a difference-in-differences model to isolate the causal impact of a systemic engineering intervention on operational risk in a sub-Saharan African manufacturing context.

This article presents a methodological framework for causal evaluation where randomized trials are not feasible.

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