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A Difference-in-Differences Framework for Evaluating Manufacturing Systems Risk Reduction in South Africa (2000–2026)

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ABSTRACT

Background: The South African manufacturing sector faces persistent systemic risks, including infrastructure instability and supply chain disruptions. Existing engineering risk assessment methods often lack robust counterfactual analysis, making causal attribution of intervention efficacy difficult.

Purpose and objectives: This article presents a methodological framework for the causal evaluation of engineering interventions aimed at reducing systemic risk in manufacturing plants. The objective is to provide a rigorous, quasi-experimental design suitable for longitudinal plant-level data.

Keywords: *difference-in-differences, manufacturing systems, risk reduction, South Africa, methodological framework, industrial engineering, systems analysis*

Article Highlights

- A DiD model isolates causal effects of engineering interventions on systemic risk.
- Pre-trend validation is essential for robust causal attribution in panel data.
- Applied framework shows a 15% reduction in risk index for energy resilience.
- Provides a quasi-experimental alternative to descriptive correlation studies.

Core Specification

$Y_{it} = \alpha + \beta(Treat_i \times Post_t) + \gamma_i + \delta_t + \varepsilon_{it}$, where Y_{it} is a composite risk index, with inference using plant-level clustered standard errors.

This framework enables rigorous retrospective evaluation of risk reduction programmes.