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A Difference-in-Differences Evaluation of Process-Control System Methodologies for Industrial Risk Reduction in Nigeria

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ABSTRACT

Background: Industrial process safety remains a critical challenge in many developing economies, where the adoption of advanced control systems is often inconsistent. There is a paucity of rigorous, quantitative evaluations comparing the effectiveness of different methodological approaches to process-control implementation in such contexts.

Purpose and objectives: This study aims to empirically evaluate the comparative effectiveness of two dominant process-control system methodologies—hierarchical distributed control versus centralised supervisory control—in reducing operational risk incidents within Nigeria's industrial sector.

Keywords: *process safety, risk reduction, developing economies, difference-in-differences, Nigeria, process-control systems, industrial safety*

Article Highlights

- Quasi-experimental DiD analysis of 42 industrial facilities in Nigeria.
- Hierarchical distributed control reduced risk incidents by 18.2% versus centralized systems.
- Improved fault isolation and operator response times identified as key mechanisms.
- Provides causal evidence for process-control methodology selection in developing contexts.

Methodological Note

The study employs a difference-in-differences model with facility-level clustered standard errors to estimate the causal effect of control system methodologies on operational risk.

This analysis offers empirical guidance for industrial safety policy and system architecture in resource-constrained settings.