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Randomised Field Trial of Process-Control System Methodologies for Yield Optimisation in South African Industrial Plants

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ABSTRACT

Background: Industrial process-control systems are critical for operational efficiency, yet there is a paucity of rigorous field evidence from the region comparing the efficacy of different methodological approaches for yield optimisation.

Purpose and objectives: This study aimed to empirically evaluate and compare the yield improvement performance of three distinct process-control system methodologies—model predictive control, statistical process control, and a rule-based expert system—within operational industrial plants.

Keywords: *process-control systems, yield optimisation, randomised field trial, industrial plants, South Africa, methodological evaluation*

Article Highlights

- Multi-site randomised field trial across 27 industrial plants in South Africa
- Model predictive control yielded 7.3% mean increase versus control group
- Statistical process control showed 3.1% improvement, expert system 1.8%
- Linear mixed-effects model with robust standard errors clustered at plant level

Methodological Note

The primary analysis used a linear mixed-effects model: $Y_{ij} = \mu + \alpha_i + \beta X_{ij} + \varepsilon_{ij}$, where Y_{ij} is yield for plant j in sector i, with robust standard errors clustered at plant level.

This study provides the first comparative experimental evidence from a randomised field trial on process-control effectiveness in the region.