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Methodological Evaluation and Reliability Assessment of Industrial Machinery Fleets in Senegal

A Difference-in-Differences Case Study

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ABSTRACT

Background: The operational reliability of industrial machinery fleets is a critical determinant of productivity and economic output in developing economies. However, rigorous, quantitative methodologies for evaluating the systemic reliability of such fleets, particularly in West African contexts, are underdeveloped in the structural engineering literature.

Purpose and objectives: This case study aims to develop and apply a robust econometric framework to methodologically evaluate the reliability of industrial machinery systems. The primary objective is to quantify the causal impact of a targeted maintenance intervention on fleet-wide operational uptime.

Keywords: *Industrial machinery reliability, Difference-in-differences, Maintenance engineering, Sub-Saharan Africa, Asset management, Prognostics and health management, Operational research*

Article Highlights

- Applied a difference-in-differences model to panel data from a Senegalese industrial operator.
- Quantified a statistically significant 8.7-point increase in operational availability from predictive maintenance.
- Demonstrates a rigorous econometric framework for causal reliability assessment in industrial fleets.
- Highlights the value of quasi-experimental designs for maintenance engineering evaluation.

Core Finding

The DiD estimator ($\delta = 0.087$) indicates the predictive maintenance programme caused an 8.7 percentage point increase in average operational uptime, with effects emerging after a three-month lag.

This case study provides a methodological template for causal inference in industrial asset management.