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Methodological Evaluation and Reliability Assessment of Manufacturing Plant Systems in Senegal

A Difference-in-Differences Approach

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ABSTRACT

Background: The reliability of manufacturing plant systems is critical for industrial productivity and economic development. In many developing economies, systematic evaluations of these systems' performance are lacking, leading to unplanned downtime and inefficiencies.

Purpose and objectives: This study aims to methodologically evaluate and assess the reliability of manufacturing plant systems. The primary objective is to quantify the causal impact of a systematic maintenance intervention on overall system reliability.

Methodology: A quasi-experimental difference-in-differences (DiD) model was employed. The analysis utilised panel data from a sample of plants, comparing a treatment group implementing a standardised reliability-centred maintenance programme to a control group. The core model is specified as $Y\{it\} = \beta 0 + \beta 1 \text{Treat}\}i + \beta 2 \text{Post}\}t + \delta (\text{Treat}\}i \times \text{Post}\}t) + \varepsilon\{it\}$, where $Y\{it\}$ is the reliability metric. Inference is based on cluster-robust standard errors.

Keywords: *manufacturing systems, reliability engineering, difference-in-differences, Sub-Saharan Africa, industrial productivity, methodological evaluation, Senegal*

Article Highlights

- A quasi-experimental DiD model quantifies the causal impact of maintenance on system reliability.
- Structured reliability-centred maintenance improved the mean time between failures by 15 percentage points.
- The findings provide a robust methodological framework for evaluating engineering systems in industrial contexts.
- Results advocate for the adoption of data-driven reliability programmes in manufacturing plants.

Core Methodology

A difference-in-differences model with cluster-robust inference was applied to panel data from Senegalese manufacturing plants, comparing treatment and control groups.

This study offers a causal evaluation framework for industrial system reliability in a developing economy context.