

# A Quasi-Experimental Framework for Evaluating Industrial Machinery Fleet Efficiency in Senegal

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## ABSTRACT

**Background:** The evaluation of industrial machinery fleet efficiency in developing economies is hindered by a lack of controlled field data and the logistical impossibility of randomised trials in operational industrial settings. Existing methods often rely on theoretical models or self-reported data, which lack robustness for causal inference.

**Purpose and objectives:** This article presents a novel quasi-experimental framework designed to measure causal efficiency gains from interventions, such as maintenance protocol changes or telematics system adoption, within operational industrial machinery fleets. The primary objective is to provide a rigorous, field-applicable methodology for structural and mechanical engineers.

**Keywords:** *quasi-experimental design, fleet efficiency, industrial machinery, Sub-Saharan Africa, field data analysis, developing economies, operational research*

### Article Highlights

- Employs a difference-in-differences design with fixed-effects panel regression.
- Validated via simulation to reliably detect efficiency improvements under field conditions.
- Designed for causal inference where randomized trials are logistically impossible.
- Recommends six months of baseline data and direct sensor logging for practitioners.

### Core Statistical Model

Fixed-effects panel regression:  $Y_{it} = \alpha + \beta(\text{Treat}_i \times \text{Post}_t) + \gamma X_{it} + \delta_i + \lambda_t + \varepsilon_{it}$ , with robust standard errors clustered at fleet level.

*This is a methodology article presenting a novel framework, not empirical results from a specific field application.*

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