AFRICAN STRUCTURAL ENGINEERING

METHODOLOGY PAPER

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

Fatou Sarr[1,2] | **Aminata Ndiaye**[3,4]
Abdoulaye Sow[3,5] | **Mamadou Diop**[6]

1 *Department of Mechanical Engineering, African Institute for Mathematical Sciences (AIMS) Senegal*
2 *Department of Electrical Engineering, Université Alioune Diop de Bambey (UADB)*
3 *African Institute for Mathematical Sciences (AIMS) Senegal*
4 *Cheikh Anta Diop University (UCAD), Dakar*
5 *Department of Civil Engineering, Council for the Development of Social Science Research in Africa (CODESRIA), Dakar*
6 *Université Alioune Diop de Bambey (UADB)*

Correspondence: fsarr@gmail.com

Received: 06 November 2019 | Accepted: 21 January 2020 | Published: 10 March 2020 | **DOI:** 10.5281/zenodo.18964924

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: $Y_{it} = \alpha + \beta(Treat_i \times Post_t) + \gamma X_{it} + \delta_i + \lambda_t + \varepsilon_{it}$, 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.