

Randomised Field Trial of a Diagnostic Framework for Efficiency Gains in Senegal's Industrial Machinery Fleets

Fatou Sarr¹|Abdoulaye Diop^{2,3}|Mamadou Ndiaye⁴
Aïssatou Diallo⁵

Department of Civil Engineering, African Institute for Mathematical Sciences (AIMS) Senegal • African Institute for Mathematical Sciences (AIMS) Senegal • Department of Electrical Engineering, Institut Sénégalais de Recherches Agricoles (ISRA) • Institut Sénégalais de Recherches Agricoles (ISRA) • Université Alioune Diop de Bambey (UADB)

Correspondence: fsarr@outlook.com

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ABSTRACT

Background: Industrial machinery fleets in developing economies often operate below optimal efficiency due to ad-hoc maintenance and diagnostic practices, leading to significant operational and financial losses. A systematic, data-driven framework for fault diagnosis and performance assessment is required.

Purpose and objectives: This study aimed to evaluate a novel diagnostic framework for machinery fleets through a randomised field trial, quantifying its impact on operational efficiency metrics including downtime, fuel consumption, and repair costs.

Keywords: *Randomised controlled trial, Industrial machinery fleets, Sub-Saharan Africa, Maintenance diagnostics, Operational efficiency, Field trial methodology, Developing economies*

Article Highlights

- Treatment group showed 17.3% higher mean efficiency versus control (95% CI: 12.1% to 22.5%).
- Gains driven by significant reductions in unplanned downtime and fuel consumption.
- Study employed a rigorous RCT design with 74 heavy machinery units across sites.
- Provides a scalable model for maintenance optimisation in developing economies.

Methodological Note

Effect estimated via linear mixed model: $Y_{ij} = \beta_0 + \beta_1 T_i + u_j + \varepsilon_{ij}$, accounting for site-level random effects.

This trial offers robust evidence for data-driven maintenance protocols.

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