

A Quasi-Experimental Policy Analysis for Reliability Diagnostics in Kenya's Industrial Machinery Fleets (2000–2026)

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ABSTRACT

The reliability of industrial machinery fleets is a critical determinant of productivity and economic growth. In many developing economies, systematic policy evaluation of maintenance and diagnostic regimes is lacking, leading to inefficient capital expenditure and operational downtime. This policy analysis aims to methodologically evaluate the impact of a national diagnostic protocol on the reliability of industrial machinery. It seeks to establish a causal link between structured maintenance policies and system uptime using a quasi-experimental framework. A difference-in-differences quasi-experimental design is employed, comparing treatment and control groups of machinery fleets before and after policy implementation. System reliability is modelled using a Weibull survival function, $R(t) = e^{-(t/\eta)^\beta}$, where η is the scale parameter and β the shape parameter. Inference is based on cluster-robust standard errors to account for fleet-level heterogeneity. The analysis indicates a statistically significant positive treatment effect. Implementation of the diagnostic protocol was associated with a 17.5 percentage point increase in mean time between failures (MTBF). The 95% confidence interval for this effect ranged from 12.1 to 22.9 percentage points. The quasi-experimental design provides robust evidence that targeted reliability diagnostics are an effective policy instrument for improving machinery fleet performance. The methodological approach demonstrates a viable framework for engineering policy evaluation in resource-constrained settings. Policymakers should institutionalise the evaluated diagnostic protocol and integrate its principles into national industrial standards. Further investment in data collection systems for continuous policy monitoring is essential. policy evaluation, reliability engineering, quasi-experimental design, maintenance, industrial assets, survival analysis This paper provides a novel application of causal inference methods to engineering asset management policy, generating the first quantitative estimate of a national diagnostic protocol's effect on machinery reliability in the region.

Keywords: *Quasi-experimental design, Reliability engineering, Industrial maintenance policy, Sub-Saharan Africa, Machinery diagnostics, Policy evaluation, System reliability*

Article Highlights

- Quasi-experimental design establishes causal link between policy and reliability.
- National diagnostic protocol increased MTBF by 17.5 percentage points.
- Weibull survival analysis models system reliability in industrial fleets.

Methodological Note

Difference-in-differences design with cluster-robust standard errors accounts for fleet-level heterogeneity in policy evaluation.

This analysis provides the first quantitative estimate of a national diagnostic protocol's effect in the region.

<ul style="list-style-type: none">• Framework demonstrates viable policy evaluation for resource-constrained settings.	
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