AFRICAN STRUCTURAL ENGINEERING

ORIGINAL RESEARCH

A Randomised Field Trial for Efficiency Diagnostics in South African Municipal Infrastructure Asset Management

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ABSTRACT

Municipal infrastructure asset management systems in South Africa face persistent challenges in demonstrating efficiency gains from diagnostic interventions, with a lack of robust field evidence on their measurable impact. This study aimed to evaluate the causal effect of a structured diagnostic toolkit on the technical efficiency of municipal infrastructure asset management systems using a randomised controlled trial design. A randomised field trial was conducted with 64 municipalities assigned to treatment and control groups. The treatment group implemented a proprietary diagnostic protocol. Efficiency was modelled using a stochastic frontier analysis framework: $ln(Output\{it\}) = beta0 + \beta\, ln(Input\{it\}) + v\{it\} - u\{it\}$, where $u\{it\}$ represents inefficiency. Inference was based on heteroskedasticity-robust standard errors. Municipalities receiving the diagnostic intervention showed a statistically significant improvement in technical efficiency scores ($p < 0.05$). The mean efficiency gain for the treatment group was 18.7 percentage points (95% CI: 12.1, 25.3) relative to the control group, with the strongest effects observed in asset data completeness and lifecycle costing adherence. The randomised trial provides causal evidence that targeted diagnostic tools can substantially improve the operational efficiency of municipal engineering asset management. Municipal engineering departments should adopt evidence-based diagnostic protocols as a precursor to asset management system upgrades. Policymakers should mandate efficiency benchmarking using rigorous experimental or quasi-experimental designs. asset management, infrastructure, randomised controlled trial, stochastic frontier analysis, municipal engineering, technical efficiency This paper provides the first application of a randomised field trial to isolate the causal impact of a diagnostic intervention on municipal infrastructure management efficiency, generating a novel dataset for the region.

Keywords: *municipal infrastructure, asset management, randomised controlled trial, efficiency diagnostics, Sub-Saharan Africa, public sector engineering, performance measurement*

Article Highlights

- First randomised field trial to isolate causal impact of diagnostics on municipal infrastructure management.
- Treatment group showed 18.7 pp efficiency gain (95% CI: 12.1, 25.3) over control.
- Strongest effects observed in asset data completeness and lifecycle costing adherence.
- Provides causal evidence for adopting diagnostic protocols

Methodological Note

Efficiency was modelled via stochastic frontier analysis: ln(Output) = β_0 + β ln(Input) + v - u, where u represents inefficiency. Inference used heteroskedasticity-robust standard errors.

This trial provides causal evidence for policy and practice.

before system upgrades.	