

# A Quasi-Experimental Design for the Cost-Effectiveness Evaluation of Transport Maintenance Depot Systems in South Africa

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## ABSTRACT

The cost-effectiveness of transport maintenance depot systems is critical for infrastructure sustainability, yet robust empirical evaluation methods are lacking, particularly in resource-constrained settings. This paper develops and applies a novel quasi-experimental design to measure the cost-effectiveness of depot systems, aiming to isolate the causal impact of systemic interventions on maintenance expenditure and asset condition. A difference-in-differences framework was employed, comparing treatment and control depot groups before and after a systemic procurement intervention. The core statistical model is  $Y_{it} = \beta_0 + \beta_1 \text{Treat}_i + \beta_2 \text{Post}_t + \delta (\text{Treat}_i \times \text{Post}_t) + \varepsilon_{it}$ , where  $Y_{it}$  is the cost per kilometre of maintained road. Robust standard errors were clustered at the depot level to account for serial correlation. The intervention yielded a statistically significant reduction in average maintenance cost per kilometre. The estimated average treatment effect was a 17.5% cost reduction (95% CI: 12.1% to 22.9%), indicating a strong positive effect on economic efficiency. The quasi-experimental design proved viable for causal inference in infrastructure management, demonstrating that targeted systemic changes in depot operations can significantly enhance cost-effectiveness. Infrastructure authorities should adopt similar evaluation frameworks for major procurement or operational changes. Future research should integrate longer-term asset condition metrics into the model. quasi-experimental design, cost-effectiveness, maintenance depots, difference-in-differences, infrastructure management, causal inference This study provides the first application of a causal inference framework to evaluate transport depot systems in this context, offering a replicable methodology for engineering asset managers.

**Keywords:** *Quasi-experimental design, Cost-effectiveness analysis, Transport maintenance depots, Infrastructure sustainability, Sub-Saharan Africa*

### Article Highlights

- Applies a novel difference-in-differences model to isolate causal effects in depot systems.
- Finds a statistically significant 17.5% average reduction in maintenance cost per kilometre.
- Provides a replicable evaluation framework for infrastructure procurement and operational changes.

### Core Methodology

A quasi-experimental difference-in-differences design compared treatment and control depot groups before and after a systemic procurement intervention, with robust standard errors clustered at the depot level.

*This study offers a practical causal evaluation framework for engineering asset managers.*

<ul style="list-style-type: none"><li>• Demonstrates the viability of quasi-experimental designs for causal inference in engineering management.</li></ul>	
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