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A Randomised Field Trial for Cost-Effectiveness Diagnostics in Ethiopian Transport Depot Maintenance Systems

Meklit Abebe[1]|**Tewodros Assefa**[2]

Department of Sustainable Systems, Hawassa University • *Department of Mechanical Engineering, Mekelle University*

Correspondence: mabebe@yahoo.com

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ABSTRACT

{ "background": "Maintenance systems for public transport depots in developing economies are often characterised by inefficiency and high operational costs. There is a paucity of rigorous, field-based evidence on the cost-effectiveness of different diagnostic and intervention protocols within these engineering management systems.", "purpose and objectives": "This case study aimed to methodologically evaluate and compare the cost-effectiveness of a proposed structured diagnostic protocol against prevailing practice in depot maintenance. The primary objective was to quantify the difference in mean cost per effective repair.", "methodology": "A randomised field trial was conducted across multiple transport depots. Depots were randomly assigned to either the intervention group, implementing a new diagnostic protocol, or a control group continuing with existing practices. Cost and outcome data were collected over a standardised period. Cost-effectiveness was analysed using a generalised linear model: $Ci = \beta 0 + \beta 1\, Ti + \beta' \xi + \epsilon i$, where Ci is the log-transformed cost per effective repair for depot i, Ti is the treatment indicator, and X_i is a vector of covariates. Inference was based on robust standard errors.", "findings": "Implementation of the structured diagnostic protocol yielded a statistically significant reduction in mean cost per effective repair. The point estimate indicates a cost reduction of approximately 22% (95% confidence interval: 15% to 28%) compared to the control group, after controlling for depot size and vehicle fleet age.", "conclusion": "The randomised trial demonstrates that a structured, evidence-based diagnostic protocol can substantially improve the cost-effectiveness of maintenance operations in this context.", "recommendations": "Transport authorities should consider adopting standardised diagnostic frameworks informed by operational data. Further research should investigate the scalability of this approach and its integration with digital maintenance management systems.", "key words": "maintenance management, randomised controlled trial, cost-effectiveness analysis, transport engineering, infrastructure management", "contribution statement": "This study provides the first application

Keywords: *Randomised controlled trial, Cost-effectiveness analysis, Transport depot maintenance, Sub-Saharan Africa, Maintenance management systems, Field experiment, Developing economies*

Article Highlights

- First application of a randomised controlled trial to depot maintenance diagnostics in Sub-Saharan Africa.
- Protocol reduced mean cost per effective repair by 22% (95% CI: 15% to 28%).
- Methodology employed a generalised linear model with robust standard errors for inference.
- Findings advocate for standardised, evidence-based frameworks in maintenance management.

Methodological Note

The analysis used a GLM: $\log(Ci) = \beta_0 + \beta_1 Ti + \beta' Xi + \varepsilon i$, where Ci is cost per effective repair, Ti is the treatment indicator, and Xi are covariates. Inference based on robust standard errors.

This trial provides rigorous field evidence for improving maintenance cost-effectiveness.