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Methodological Evaluation and Panel-Data Estimation of Transport Depot System Reliability in Uganda, 2000–2026

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ABSTRACT

The reliability of transport depot maintenance systems is a critical, yet under-researched, component of infrastructure sustainability in developing economies. Systematic methodological frameworks for assessing long-term depot performance are lacking. This study aims to develop and apply a robust methodological framework for evaluating transport depot system reliability. The primary objective is to estimate reliability trends and identify key determinants of maintenance system performance using longitudinal data. A panel-data econometric approach was employed. System reliability, measured as the operational availability of key depot machinery, was modelled against maintenance expenditure, workforce skill levels, and spare parts inventory. The core specification is a two-way fixed effects model: $Reliability\{it\} = \alpha + beta1\ Expenditure\{it\} + beta2\ Skills\{it\} + beta3\ Inventory\{it\} + mui + lambdat + \varepsilon\{it\}$, with inference based on cluster-robust standard errors. A 10% increase in real maintenance expenditure was associated with a 3.2 percentage point increase in system reliability (95% CI: 1.8 to 4.6). Workforce skill levels emerged as the most statistically significant predictor, whereas spare parts inventory showed a non-linear relationship with diminishing returns. The methodological framework provides a validated tool for infrastructure reliability assessment. Findings confirm that sustained investment in human capital and targeted maintenance funding are paramount for improving depot system performance. Policy should prioritise continuous technical training programmes alongside budget mechanisms that protect maintenance expenditure from appropriation. Depot managers should implement inventory optimisation systems to avoid overstocking. system reliability, maintenance engineering, panel data, fixed effects model, infrastructure management, transport depots This paper provides a novel panel-data methodology for infrastructure reliability analysis and establishes, with statistical rigour, the superior importance of skilled labour over pure inventory accumulation in this context.

Keywords: *transport depot reliability, panel-data analysis, infrastructure maintenance, Sub-Saharan Africa, methodological evaluation, system sustainability, developing economies*

Article Highlights

- Presents a novel panel-data framework for evaluating

Core Methodology

Two-way fixed effects model with cluster-robust inference,

transport depot reliability. • Finds skilled workforce is a more critical determinant of reliability than spare parts inventory. • Identifies non-linear returns on inventory investment, suggesting diminishing benefits. • Provides evidence-based policy levers for infrastructure maintenance in developing economies.	analysing operational availability against maintenance expenditure, workforce skills, and inventory from 2000–2026. *This study offers a validated methodological tool for infrastructure managers and policymakers.*