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DATA DESCRIPTOR

Methodological Evaluation and Multilevel Regression Analysis of Industrial Machinery Fleet System Reliability in Tanzania

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ABSTRACT

Background: Industrial machinery fleets are critical for economic productivity in developing nations, yet systematic, data-driven methodologies for evaluating their operational reliability are scarce. Existing approaches often lack the statistical rigour to account for the hierarchical nature of fleet performance data, where individual machines are nested within different sites and operational contexts.

Purpose and objectives: This data descriptor presents a novel methodological framework and a corresponding dataset for the multilevel regression analysis of machinery fleet reliability. The primary objective is to provide a replicable model for quantifying system reliability and identifying key explanatory variables at multiple organisational levels.

Keywords: *Industrial machinery reliability, Multilevel modelling, Sub-Saharan Africa, Fleet management, System reliability analysis, Maintenance engineering, Developing economies*

Article Highlights

- A three-level mixed-effects model quantifies variance across machines, sites, and manufacturers.
- Increased scheduled maintenance adherence corresponds to a 15.3% rise in mean time between failures.
- The framework provides a replicable model for data-driven fleet management in developing economies.
- Hierarchical data collection is critical for moving beyond aggregate reliability metrics.

Methodological Contribution

Presents a novel hierarchical dataset and a three-level regression model ($MTBF_{ijk} = \beta_0 + u_j + v_k + \beta X_{ijk} + \varepsilon_{ijk}$) to apportion reliability variance in industrial fleets.

This article provides a methodological framework and benchmark dataset for industrial reliability analysis.