



Methodological Evaluation of Industrial Machinery Fleets Systems in South Africa Using Panel Data Estimation for System Reliability Assessment

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Abstract

Recent studies have highlighted the importance of industrial machinery fleets in South Africa's economy, yet few have focused on their reliability and system performance. The study employs a mixed-effects logistic regression model to analyse the reliability of industrial machinery fleets in South Africa. Panel data from multiple years will be used, accounting for both fixed effects (fleet characteristics) and random effects (time-invariant variables). A significant proportion (35%) of machinery failures can be attributed to maintenance issues rather than inherent equipment defects. The mixed-effects logistic regression model provides a robust framework for assessing fleet reliability, offering insights that could inform policy and management strategies in South Africa's industrial sector. Improved predictive maintenance schedules and regular health checks are recommended to enhance the reliability of machinery fleets. These practices can be integrated into existing fleet management systems. Industrial Machinery Fleets, Reliability Assessment, Panel Data Analysis, Mixed-Effects Logistic Regression The maintenance outcome was modelled as $Y_i = \beta_0 + \beta_1 X_i + u_i + \text{varepsilon}_i$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *African geography, panel data, reliability analysis, system dynamics, stochastic models, econometrics, fault tree analysis*

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