



# Panel Data Estimation of System Reliability in South African Manufacturing Plants: A Methodological Evaluation

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## Abstract

This Data Descriptor focuses on methodological advancements in assessing system reliability within South African manufacturing plants. Panel data analysis was applied using mixed-effects logistic regression models to estimate system failure probabilities over time. Robust standard errors were employed to account for within- and plant variations. The analysis revealed significant differences in system reliability across different manufacturing sectors, with electronics manufacturing showing a higher failure rate compared to mining. This study provides empirical evidence on the effectiveness of panel data methods in assessing system reliability, offering insights for improving plant maintenance and reducing downtime. Manufacturers should consider sector-specific factors when implementing reliability models to enhance their predictive accuracy and operational efficiency. The maintenance outcome was modelled as  $Y_i = \beta_0 + \beta_1 X_i + u_i + v_i \epsilon_i$ , with robustness checked using heteroskedasticity-consistent errors.

**Keywords:** *South Africa, Panel Data, Mixed-Effects Models, System Reliability, Logistic Regression, Manufacturing Industry, Methodological Evaluation*

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