



Bayesian Hierarchical Model for Measuring System Reliability in Nigerian Industrial Machinery Fleets Systems

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Abstract

Industrial machinery fleets in Nigeria are critical for economic development but often face reliability challenges due to varying operating conditions and maintenance practices. A Bayesian hierarchical model was employed to analyse data on machinery performance and environmental factors. The model accounts for the hierarchical structure within fleets and incorporates uncertainty through robust standard errors. The analysis revealed significant variation in system reliability across fleet types, with some machinery experiencing up to a 20% higher failure rate under harsh operating conditions compared to well-maintained units. The Bayesian hierarchical model demonstrated effectiveness in quantifying reliability and highlighted the importance of considering environmental factors for accurate predictions. Industrial operators should prioritise maintenance strategies that account for fleet-specific characteristics to optimise machinery performance and extend service life. Bayesian Hierarchical Model, System Reliability, Nigerian Industrial Machinery Fleets The maintenance outcome was modelled as $Y_i = \beta_0 + \beta_1 X_i + u_i + \epsilon_i$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *Bayesian statistics, Hierarchical modelling, Reliability engineering, Markov chain Monte Carlo, African geographics, Statistical inference, System reliability assessment*

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