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Bayesian Hierarchical Model for Measuring System Reliability in South African Transport Maintenance Depots: A Methodological Evaluation

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Abstract

Bayesian hierarchical models have been used in various fields to analyse complex systems, including transport maintenance depots in South Africa. A Bayesian hierarchical model was developed and applied to data from South African transport maintenance depots, incorporating both fixed effects and random effects to account for variability across different depots and components. The analysis revealed a significant proportion ($p > 0.95$) of system failures attributed to component degradation over time, which the model accurately captured through its hierarchical structure. The Bayesian hierarchical model provided robust estimates of system reliability with well-calibrated uncertainty intervals, enhancing decision-making in maintenance planning and resource allocation within South African transport systems. Recommendation for further study includes expanding the model to include additional factors such as environmental conditions and operational practices across different depots. The maintenance outcome was modelled as $Y\{\} = beta\,0 + beta\,1\,X\{\} + ui + varepsilon\{\}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *South African, Bayesian, Hierarchical, Model, Reliability, Maintenance, Depot*

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This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.

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