



Bayesian Hierarchical Model for Measuring System Reliability in Ethiopian Transport Maintenance Depots Systems

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Abstract

Transport maintenance depots (TMDs) play a crucial role in ensuring the reliability of vehicles operating within Ethiopia's transportation infrastructure. A Bayesian hierarchical model was developed and applied to data from Ethiopian TMDs. This approach accounts for variability across depots while estimating overall system reliability with robust uncertainty quantification. The analysis revealed significant variation in the effectiveness of maintenance procedures between different depots, highlighting specific areas needing improvement. Bayesian hierarchical models provide a nuanced understanding of TMD performance by accounting for both systematic and random effects within data. Further research should focus on validating these findings with larger datasets or additional empirical studies to generalize the model's applicability across Ethiopian transportation systems. The maintenance outcome was modelled as $Y = \beta_0 + \beta_1 X + u_i + \text{varepsilon}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *Bayesian statistics, Ethiopia, Hierarchical modelling, Reliability analysis, Transport maintenance depots, Markov chain Monte Carlo, Spatial statistics*

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