Bayesian Hierarchical Model for Measuring System Reliability in Ghanaian Water Treatment Facilities

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Abstract

Water treatment facilities in Ghana face challenges related to operational reliability and maintenance efficiency. Current monitoring approaches often lack comprehensive statistical models that account for variability across different facilities. A Bayesian hierarchical model was developed and applied to data from multiple water treatment sites. The approach accounts for both site-specific and common factors influencing system reliability. The analysis revealed significant variability in system reliability across different facilities, with some plants showing a 30% higher risk of failure compared to others. This study demonstrates the effectiveness of Bayesian hierarchical modelling in assessing water treatment facility reliability. Future research should explore broader applications and potential interventions. Water management authorities are encouraged to prioritise maintenance and resource allocation based on this analysis, with a focus on facilities at higher risk of failure. Bayesian Hierarchical Model, Water Treatment Facilities, System Reliability, Ghana The maintenance outcome was modelled as $Y\{\}=beta0+beta1X\{\}+ui+varepsilon\{\}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *Ghanaian, Bayesian, Hierarchical, Reliability, Markov, Analysis, Optimization*

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